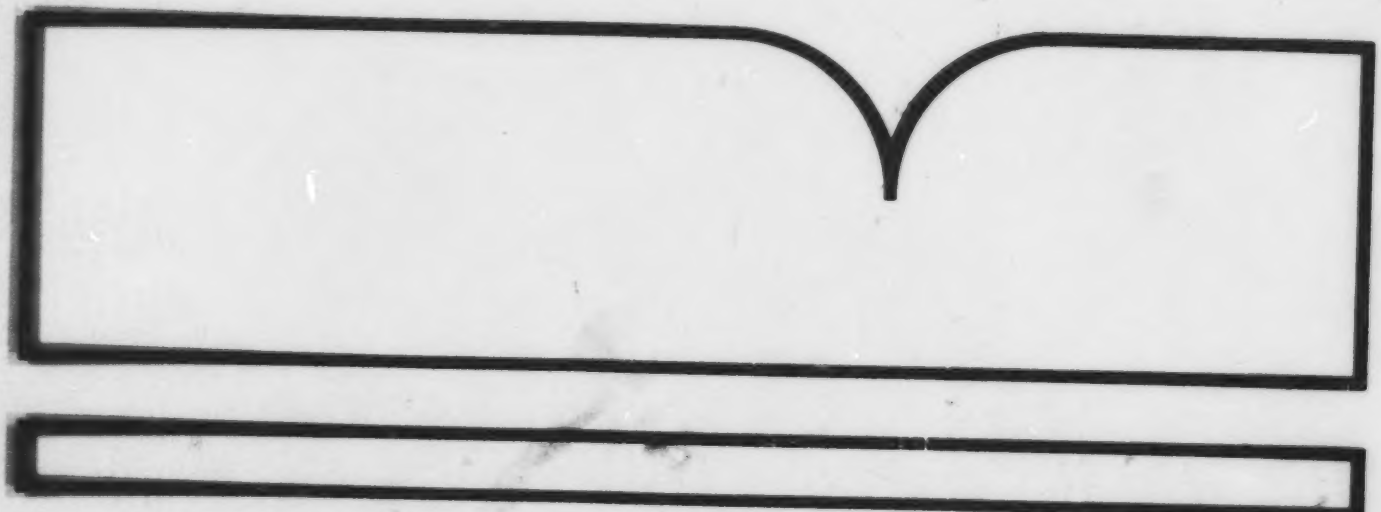
PB83-140145

Interim Report on the Status of the In-House Particulate Trap Study

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Feb 82



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Interim Report on the Status of the In-House Particulate Trap Study

by

Larry C. Landman

February, 1982

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16. ABSTRACT

This interim report summarizes the results (through January 21, 1982) of an on-going, in-house study whose purpose was to evaluate the low mileage performance of diesel exhaust particulate traps. This program has, through 1981, tested 15 particulate traps using three production vehicles. Most of these traps were successful in producing significant reductions in total particulate emissions. It is important to note that the program is concerned only with the performance of particulate traps at low mileage; hence, no durability data were generated.

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BACKGROUND

Diesel engines are becoming available in increasing numbers in passenger car service because of their good fuel economy in comparison to cars equipped with conventional gasoline fueled engines. Although the exhaust of vehicles equipped with Diesel engines is relatively clean with respect to unburned hydrocarbons (HC) and carbon monoxide (CO), it contains total particulate emissions (TP) that are 30 to 50 times greater than those produced by vehicles equipped with catalyst equipped, gasoline engines.

Several approaches to the control of Diesel emissions are being pursued by the automotive industry, EPA, and others. These include operating mode modifications, engine design and component modifications, fuel modifications, and exhaust treatment devices.(3)*

This interim report summarizes the results (through January 21, 1982) of an on-going, in-house study. The purpose of that study is to evaluate the low mileage performance of Diesel exhaust particulate traps. It is important to note that this program is concerned only with the performance of particulate traps at low mileage; hence, no durability data were generated.

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*Numbers in parentheses designate References at the end of this paper

CONCLUSIONS

1. Durability data are conspicuously lacking for most of these traps. However, we are shipping the NGK #1 trap (which has shown, in this test program, good regenerative capabilities and trapping efficiencies in excess of 60%) to Southwest Research Institute, an EPA contractor, to conduct such durability testing. Also, SwRI is testing a Corning EX-47 12 inch non-catalyzed trap and currently has accumulated over 18,000 miles on it. EPA selected these two traps for high mileage testing after evaluating their performances in this low mileage program.

2. The procedure used in-house by EPA, running a vehicle at 60 mph for 8 minutes throttled and then for 4 minutes unthrottled, is an adequate technique for regenerating traps under laboratory conditions; however, it might not be practical in everyday driving. Other methods have been reported, the latest are the methods used by Johnson-Matthey (i.e. injecting fuel into the cylinder during the exhaust stroke) and by Ford (i.e. using an externally fueled burner (6)).

3. Sulfate emissions, especially on the highway (HWFE) test cycle, were increased with catalyzed traps. However, several catalyzed traps were able to regenerate on the HWFE cycle and thus may not require a special regeneration cycle.

4. CO emissions were higher on the regeneration cycle than on either the FTP or HWFE cycles due to the increase in the fuel/air ratio associated with the regeneration method which was used.

5. None of the traps tested in this program suffered a "melt down" due to the high temperatures. However, the Corning/UOP cracked, and the Texaco A-1R separated.

6. The traps which were successfully regenerated all displayed an oscillatory nature in their TP emissions and exhaust gas back pressure (EGBP).

7. The fuel economy data were mixed and not statistically significant. A discussion of the effect of trap-oxidizers on fuel economy can be found in Appendix E.

TEST PROGRAM

This program has, through 1981, tested 15 particulate traps using three production passenger cars. The test vehicles which were used are a 1975 model year Mercedes Benz 300D, 1978 model year Peugeot 504 Diesel, and 1981 model year Toyota Crown Super-Deluxe Diesel. (This latter vehicle is not currently certified for sale in the USA.) A complete description of these vehicles can be found in Tables 1 through 3 respectively. A listing of the traps can be found in Table 4.

Emission data generated in the program can be found in Appendix A. Also compiled (in Appendix B) are the emissions data on all certification vehicles tested at EPA's Motor Vehicle Emission Laboratory for which particulate data were measured.

Due to the nature of this program, testing of a given trap was usually terminated for one of the following four reasons:

1. Trapping efficiency less than 30%,
2. Very high initial exhaust gas back pressure (EGBP),
3. Inability of trap to be regenerated using throttling, or
4. Damage to the trap.

Preliminary results of Ames tests from vehicles in this program can be found in Appendix C-1. Appendix C-2 contains preliminary Ames results from other EPA test programs and includes data from in-use and certification vehicles.

A summary of these preliminary data is presented in Appendix C-3. The reader should be cautioned that there may be substantial variability in Ames data. There may be problems in variability resulting from 1) extractions at varying periods of time prior to Ames testing, 2) differing Ames results from testing portions of the same sample on different days, 3) varying exhaust NO_2 concentrations during sample collection, and 4) differing Ames results from different samples generated by the same car over the same test sequence. (16, 17, and 18)

Since these data are preliminary and are few in number, we have not generated any conclusions from these data. These data will be supplemented in the near future. At that time, we plan to do additional quantitative analyses.

The Ames procedure was described by an EPA contractor, Southwest Research Institute (15):

> The term "Ames Bioassay" is colloquial, and it refers to a bacterial mutagenesis plate incorporation assay with Salmonella typhimurium according to the method of Ames, et al. This bioassay determines the ability of chemical compounds or mixtures to cause mutation of DNA in the bacteria, positive results occurring when histidine-dependent strains of bacteria revert (or are mutated) genetically to forms which can synthesize histidine on their own. The observable positive indication of mutation is the growth of bacterial colonies on plates of nutrient media containing minimal histidine, with the number of revertants per amount of substance tested (or "specific activity") being the quantitative result. The observable negative indication is the lack of such growth. A third result occurs when the substance tested is toxic to the bacteria, but this result can not be interpreted in terms of mutagenesis. Results of the Ames Bioassay have been shown to correlate strongly with carcinogenic action on animals for individual chemicals. No such results are known for complex mixtures of chemical substances.

Table 1

TEST VEHICLE DESCRIPTION

1975 Mercedes Benz 300D

Vehicle Identification Number: 11511412019885

Engine

type	4 Stroke Cycle IDI Diesel, In-Line 5
bore x stroke	3.58 x 3.64 inches
displacement	3.0 Liter/183 CID
compression ratio	21.0:1
maximum power @ rpm	77 horsepower @ 4000 RPM
fuel metering	Diesel Fuel Injection

Drive Train

transmission type	3-speed automatic

Chassis

type	4 door sedan
tire size	175 SR14
test weight	4000 pounds
dynamometer horsepower	13.2

Table 2

TEST VEHICLE DESCRIPTION

1978 Peugeot Diesel 504

Vehicle Identification Number: 504ACO-2700783

Engine

type	4 Stroke Cycle IDI Diesel, In-Line 4
bore x stroke	3.7 x 3.26 inches
displacement	141 CID
compression ratio	22.5:1
maximum power @ rpm	71 Horsepower @ 4500 RPM
fuel metering	Diesel Fuel Injection

Drive Train

transmission type	4-speed manual
axle ratio	3.70
N/V	51.4

Chassis

type	4 door sedan
tire size	175 x 14
test weight	3500 pounds
dynamometer horsepower	12.3

Table 3

TEST VEHICLE DESCRIPTION

1981 Toyota Diesel Crown Super-Deluxe

Vehicle Identification Number: K-LS110-SEMFSY

Engine

type	4 Stroke Cycle IDI Diesel, In-Line 4
bore x stroke	3.54 x 3.39 inches
displacement	2188cc/133.5 CID
compression ratio	21.5:1
maximum power @ rpm	62 horsepower @4200 RPM
fuel metering	Diesel Fuel Injection

Drive Train

transmission type	5-speed manual

Chassis

type	4 door sedan
tire size	E78-14B
test weight	3000 pounds
dynamometer horsepower	12.0

TABLE 4

SUMMMARY OF TRAPS USED IN IN-HOUSE TEST PROGRAM THROUGH JANUARY 21, 1982

TRAP	CAT. ?	SUBSTRATE	FLOW	REGENERATIONS	VEHICLE	DATES TESTED
Texaco A-1R	No	'Carpenter 20' mesh	Axial	Only partial	Mercedes	5/79 - 6/79
Texaco A-1R with CST-1 coating	Yes	'Carpenter 20' mesh	Axial	Regen on HWFE	Mercedes	7/79
Texaco A-1R with CST-1 coating #2	Yes	'Carpenter 20' mesh	Axial	Regen on HWFE	Mercedes	10/79 - 1/80
Balston filter (disposable trap)	No	Fibrous material	Radial	Not attempted	Mercedes	9/79 - 10/79
Johnson-Matthey JM-4 #1	Yes	'309 Stainless' mesh	Radial	Regen on HWFE	Peugeot	11/79 - 12/79
Johnson-Matthey JM-4 #2	Yes	'309 Stainless' mesh	Radial	Regen on HWFE	Peugeot	3/80 - 7/80
ICI Saffil	Yes	Mesh of alumina 'Saffil' fibers	Radial	Yes; 3 times avg 450 Mi	Mercedes	8/79 - 9/79 & 10/79
ICI Saffil Generation #4	Yes	Mesh of alumina 'Saffil' fibers	Radial	Not attempted	Mercedes Toyota	10/80 - 4/81 9/81 - 10/81
Corning EX-40 6" non-catalyzed	No	Ceramic	Wall	Not attempted	Mercedes	9/79
Corning EX-47 6" non-catalyzed	No	Ceramic	Wall	Not attempted	Mercedes	1/80
Corning EX-47 6" with CST-1 Coating	Yes	Ceramic	Wall	Attempted; but no EGBP drop	Mercedes	1/80 - 2/80
Corning EX-47 12" non-catalyzed	No	Ceramic	Wall	Yes; 2 times over 200 Mi	Mercedes	2/80 - 4/80
Corning EX-47 12" with UOP Coating	Yes	Ceramic	Wall	Yes; 2 times 161 miles	Mercedes	4/81 & 9/81 - 10/81
NGK #1 (200 cpsi, 0.012" thickness)	No	Ceramic	Wall	Yes; 3 times avg 479 Mi	Toyota	10/81 - 1/82
NGK #2 (100 cpsi, 0.017" thickness)	No	Ceramic	Wall	Yes; 4 times avg 115 Mi	Mercedes	11/81 - 1/82

REGENERATION TECHNIQUE

Regeneration is any procedure by which the trap is purged of accumulated particulates (usually by oxidation) and is returned to its "zero-mile" condition.

The technique used in this program to achieve the conditions necessary for regeneration to occur (i.e. achieve a temperature of at least 950°F) was to throttle the intake air for 8 minutes followed by an additional 4 minutes of unthrottled operation, all while driving at 60 mph steady state on a chassis dynamometer. Throttling increases the fuel/air ratio which increases the exhaust gas temperature. The hot exhaust gas causes regeneration of the trap. Throttling was accomplished by having an individual (other than the driver) manually operate a throttle which EPA had installed between the air cleaner and the intake manifolds.

Three other regeneration techniques were considered for use in this program:

1. A secondary flame, such as used in oil furnaces would produce high temperatures in the trap without affecting engine performance.

2. Operation of the engine at high speed and high load conditions can produce sufficiently high exhaust gas temperatures.(6)

3. Catalysts might provide a sufficient exotherm to raise the exhaust gas temperature sufficiently to oxidize the Diesel particulates under certain operating conditions.

The technique of throttling was considered the easiest to do and requires little special equipment.

While this method is acceptable for laboratory testing, it is not necessarily representative of a system which might be used commercially.

Trap Description and History

Only mechanical particulate trapping systems were tested as part of this study. (Other systems such as electrostatic precipitation, thermal precipitation, and cyclone separation have also been investigated in other studies as possible trapping systems for particulate emissions from light-duty Diesel powered vehicles.(6))

Mechanical trapping mechanisms, shown in Figure 1, consist of impaction, interception, and diffusion.

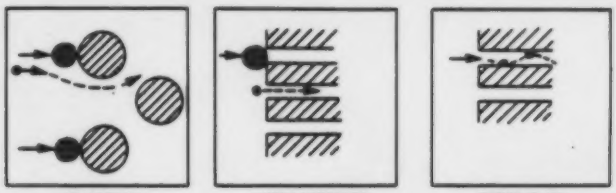


Figure 1

Mechanical Trapping Mechanisms (6)

Impaction and diffusion are the primary trapping mechanisms of a wire mesh or ceramic fiber trap. The larger sizes of particulates impact on filaments of the mesh and adhere to the surface of the filaments or [to] particulate material previously collected on the filaments. Some of the smaller sizes of particulates migrate to the surfaces of the filament or previously collected particulate material by diffusion and are retained. This type of trap is sometimes called a nonblockable trap, because an exhaust flow path will usually exist which cannot be blocked by the accumulation of particulate matter. Although these traps tend to have relatively low pressure drops, disadvantages that have been observed include moderately low collection efficiency and blow-off of collected particulates.

Interception is the primary trapping mechanism of a porous material trap, although diffusion may also enhance the collection efficiency of this type of trap. Particulates larger than approximately the mean pore size of the material are intercepted and prevented from passing through the material. As

additional particulate material is accumulated on the surface of the trapping material, the effective pore size may be reduced, thereby causing efficiency to increase with the collection of smaller sizes of particulates. Traps using the interception method of collection are sometimes called blockable, or full filtration traps. Although blow-off of collected particulates is not a problem with this type of trap, back pressure and rate of back pressure increase tend to be somewhat higher than with non-blockable traps.(6)

The 15 traps tested to date are:

1. Texaco A-1R Trap:

This trap was 6.7 inches in diameter and 23 inches in length. It employed axial flow and used as a substrate a metal wool mesh coated with alumina (called "Carpenter 20"). (See Figure 2.) The trap was received from Texaco Laboratories on April 26, 1979, was installed on the Mercedes 300D, and began testing on May 5, 1979.

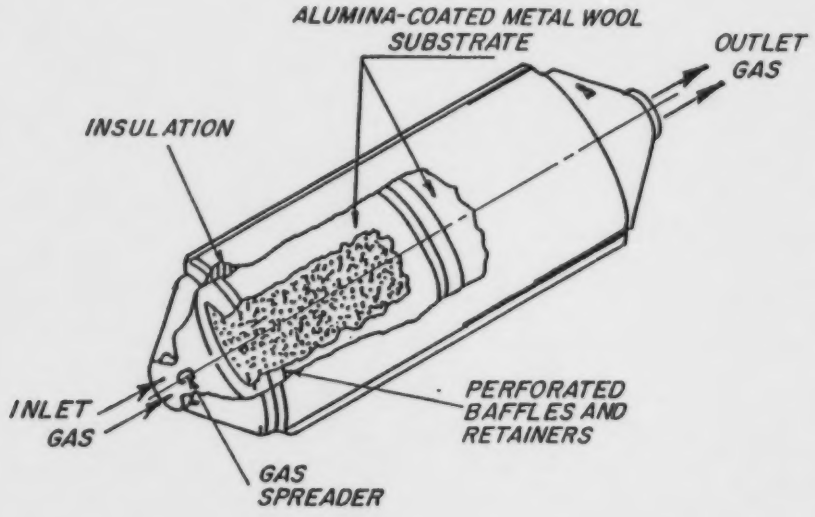


Figure 2

A Typical Texaco Trap with a
Portion of the Container Removed

Exhaust backpressure (EGBP) readings were taken two or three times a day at 40, 50, and 60 MPH steady state conditions. The plan was to perform mileage accumulation until the EGBP was twice the "zero-mile" value of 30.9 inches H_2O at 60 MPH. (No muffler was installed.)

After accumulating 780 miles, the trapping efficiency had dropped from 60% to 30% and the EGBP had doubled. The trap was then regenerated using throttling. After that regeneration, the efficiency had returned to the "zero-mile" values; however, the EGBP was at 50.0 inches H_2O at 60 MPH. A visual inspection of the trap showed a "clean" core with substantial particulates on the sides.

The trap was sent to the local Climax Molybdenum laboratory, where it was installed in a recirculating oven at 925°F for 6 1/2 hours. Visual inspection indicated no residual carbon particulates. The trap was reinstalled on the test vehicle and the EGBP was measured at 34.9 inches of H_2O at 60 MPH which was very close to the "zero-mile" values. Testing on this trap was then terminated.

This trap exhibited a significant reductions in both TP (50%) and HC (40% to 50%) emissions and relatively low EGBP penalty.

2. Englehard CST-1 Coating of a Texaco A-1R Trap:

A second Texaco A-1R trap was coated by Engelhard with a catalytic material they designated as CST-1. Since this coating is being patented, Englehard did not reveal its composition to EPA.

Prior to testing, a visual inspection of the trap showed a separation between the coated mesh and the trap tubing. This separation was apparent at both ends but was not continuous since light could not be seen through any part of the trap. The decision was made to install the trap on the Mercedes and to begin testing.

Daily measurements failed to show any increase in EGBP with mileage accumulation. However, after the initial two "zero-mile" highway (HWFE)

tests, the TP measured on the HWFE tests had increased to about three times the baseline (i.e. dummy trap or empty trap container) values.

In order to explain the high TP emissions measured on the HWFE test cycles, additional tests were performed on July 23, 1979, and sulfate (SO_4) measurements of the TP data were taken. This additional testing consisted of a cold start 2-bag LA-4, a 10 minute soak, a hot start 2-bag LA-4, a preconditioning highway cycle, and two HWFE sample cycles. The resulting data appear in the following table:

Test Cycle	TP(g/m)	SO_4(g/mi)	% SO_4
Cold LA-4 Bag 1	.450	.0631	14.0%
Cold LA-4 Bag 2	.297	.0141	4.75%
Hot LA-4 Bag 1	.347	.0922	26.6%
Hot LA-4 Bag 2	.257	.0167	6.49%
HWFE	.699	.4310	61.7%
HWFE	.653	.4350	66.6%

The above data explain the high TP emissions found on the HWFE tests since most of that total particulate was sulfate particulates rather than carbon particulates.

This trap exhibited a significant reduction in HC (90%), CO (over 95%), and FTP TP (40%) emissions. Also, there was no indication that regeneration was necessary in the approximately 1,000 miles accumulated.

Ames tests performed on the TP (only strains TA98 and TA100 were run due to small quantity of extractable organics) indicated fairly normal Diesel particulate activity. A thorough analysis of the results of all the Ames tests associated with this program will be performed by EPA in the future.

3. Englehard CST-1 Coating of a Second Texaco A-1R Trap:

The first Texaco-Englehard CST-1 trap had a visible separation of the trapping medium from the wall. While this separation did not run the full length of the trap, it appeared that the trap may have been damaged either during the catalyst coating operation or during thermocouple placement. The first (non-catalyzed) A-1R trap was oven-baked to remove all particulate and sent for catalyst treating. There was no separation evident in this trap, which was designated CST-1 #2. This second catalyzed A-1R trap was installed on the same car, and tested to determine if the lower trapping efficiency of the first catalyzed trap was due to that separation or to some other phenomena.

Zero-mile testing of this trap confirmed the reduced TP trapping efficiency found on the HWFE test cycles using the first catalyzed A-1R trap. Based on the high sulfate emissions, that reduced efficiency is probably due to the increased sulfates generated in the trap which would raise the total particulate sampled during the test. These traps are thus replacing carbon based particulates with sulfate particulates. This replacement makes the trap appear to be less efficient.

To determine the durability of the trap, the test vehicle with the CST-1 #2 trap installed was put on mileage accumulation. The mileage was accumulated on a dynamometer using an LA-4 driving cycle. Exhaust gas back pressure (EGBP) measurements were taken at 40, 50, and 60 mph steady state every 22.5 miles. Highway cycles were run when the EGBP reached higher levels. These highway cycles usually caused the EGBP to drop significantly. Mileage accumulation continued for approximately 2,000 miles.

The EGBP rose very gradually as shown below:

Miles Accumulated	EGBP (inches of water) 40 mph	50 mph	60 mph
"Zero-mile"	17.88	26.10	38.02
249	19.30	28.08	41.45
492	20.01	29.40	42.13
742	20.01	30.06	42.83
1,000	20.70	23.77	44.93
1,220	22.76	33.36	47.06
1,510	24.53	37.72	55.22
1,757	25.55	39.76	58.35
1,965	24.53	38.74	57.30

The emissions data from the testing, performed after the mileage accumulation, were scattered; however the data demonstrate that the efficiency of the trap to reduce FTP TP emissions was greatly diminished.

Still not resolved is the issue of how this trap would perform on low sulfur fuel.

4. Balston Filter:

In order to evaluate the feasibility of a disposable trap, Balston Filter Corporation was contacted. For a feasiblity study, a 7-parallel tube configuration was specified. Each tube was constructed of fibrous material and plugged at the outlet end, thus producing radial flow. The filter holder was not installed under the car but rather at the inlet to the dilution tunnel.

Unfortunately, one of the seven trapping elements failed after the second sequence of zero-mile tests. The trapping efficiency (for FTP TP) dropped from 90% on the first FTP to 30% on the second FTP. Due to the failure of one of the trapping elements, we cannot determine whether the efficiency would have stabilized; and, if so, what that efficiency would have been.

5. Johnson-Matthey JM-4 #1 Trap:

The Johnson-Matthey JM-4 #1 trap is a catalyzed knitted wire (called "309 Stainless") mesh design which is incorporated into the exhaust manifold. This trap was 5.1 inches in diameter and 16.9 inches in length. The exhaust gas flows radially through the mesh where oxidation of the Diesel particulate is supposed to take place. (See Figure 3.) Both the exact configuration of the mesh and the composition of the catalyst were considered trade secrets, and neither was revealed to EPA. The trap was installed on a 1978 Peugeot 504 Diesel.

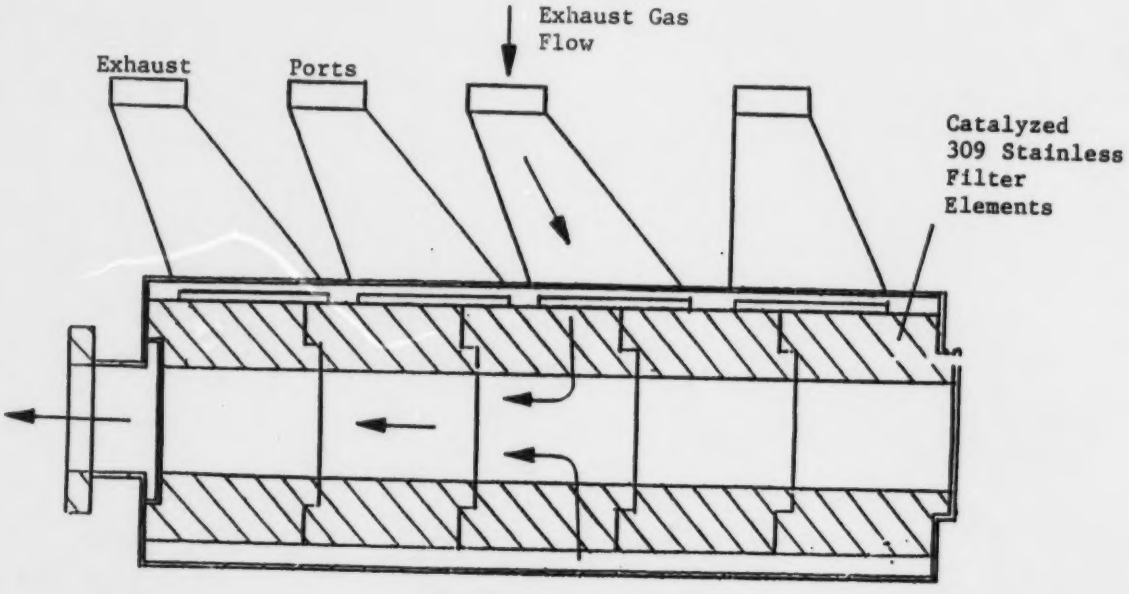


Figure 3

The Johnson-Matthey Particulate
Trap and Exhaust Manifold (JM-4)

"Zero-mile" testing indicated significant reductions of HC, CO, and FTP TP emissons; however, the HWFE TP emission was higher than the baseline values. The FTP TP trapping efficiency was reduced to zero by the 600 mile point. The 600 miles were accumulated by running LA-4 cycles with occasional HWFE cycles. The EGBP would drop significantly when HWFE cycles were run. Because the FTP, HWFE, and LA-4 tests at 600 miles all

showed TP emissons higher than the corresponding baseline values and because the EGBP was quite high, the testing of this trap was terminated.

In order to explain the high TP emissions measured on the test cycles, additional tests were performed, and SO_4 data were taken. This additional testing consisted of a cold start 2-bag LA-4, a hot start 2-bag LA-4, and two HWFE test cycles. That sequence of four tests was performed both with the trap and without the trap (i.e. baseline). Those data appear in the following table:

Trap	Test Cycle	TP(g/mi)	SO_4(g/mi)	% SO_4
Baseline	Cold LA-4 Bag 1	.545	.01714	3.14%
	Cold LA-4 Bag 2	.592	.0074	1.25%
	Hot LA-4 Bag 1	.401	.0127	3.17%
	Hot LA-4 Bag 2	.384	.00576	1.50%
	HWFE	.374	.0190	5.08%
	HWFE	.302	.0167	5.52%
JM-4-#1	Cold LA-4 Bag 1	.392	.268	68.4%
	Cold LA-4 Bag 2	.164	.038	23.1%
	Hot LA-4 Bag 1	.564	.447	79.3%
	Hot LA-4 Bag 2	.183	.1445	79.0%
	HWFE	.677	.586	86.5%
	HWFE	.784	.677	86.3%

The above data explain the high TP emissions since most of that total particulate was sulfate particulates rather than carbon particulates.

6. Johnson-Matthey JM-4 #2 Trap:

The JM-4 #2 trap is quite similar to the JM-4 #1 trap with the exception that EGBP is lower and more stable in the JM-4 #2. This is due to a redesign of the earlier version which improved flow characteristics, according to Johnson-Matthey.

Testing of the trap for 600 miles produced emission results similar to the JM-4 #1 trap except that the FTP TP emissions did not deteriorate. Johnson-Matthey personnel suggested that the solution to the increased sulfate emissions was to put an additional 1,000 miles on the trap. The 1,000 miles were accumulated at 55 mph steady state conditions. However, that added mileage did not substantially reduce the sulfate emissions.

This trap was then tested using a low sulfur content fuel (less than 12 ppm sulfur). Those tests indicated substantial reductions in HC (95%), CO (96%), and FTP TP (60%) emissions with only a moderate increase in HWFE TP emissions (28%) relative to the baseline data.

7. ICI Saffil Trap:

This trap, designed by Imperial Chemical Industries Limited (ICI), consists of a series of parallel labyrinths which facilitate diffusion trapping of submicron particles on the "Saffil" (a polycrystalline alumina, Al_2O_3) fiber as the exhaust gas flows radially down the labyrinths formed by crimped woven wire. (See Figures 4 and 5.) (The current use of the "Saffil" fiber is in furnace linings at about 1450°C.) Silver nitrate was applied to the fibers as a catalyst. The dimensions of the container were 5.3 inches in diameter and 20.8 inches in length.

The trap was installed on the Mercedes, and testing began on August 2, 1979. "Zero-mile" data indicated a trapping efficiency of 45% (for FTP TP). After 600 miles, the EGBP had doubled and the TP emissions exceeded the baseline values. At this point, the trap was regenerated by throttling.

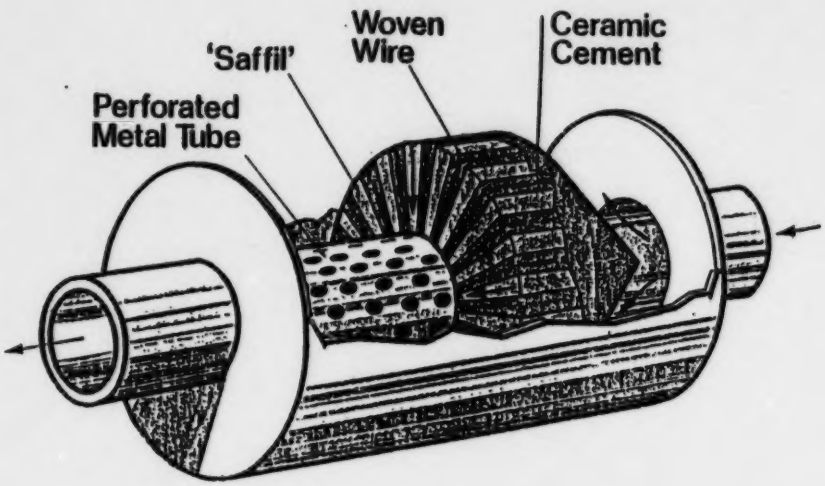


Figure 4

The ICI Particulate Trap with Part of
the Container and Filter Elements Removed

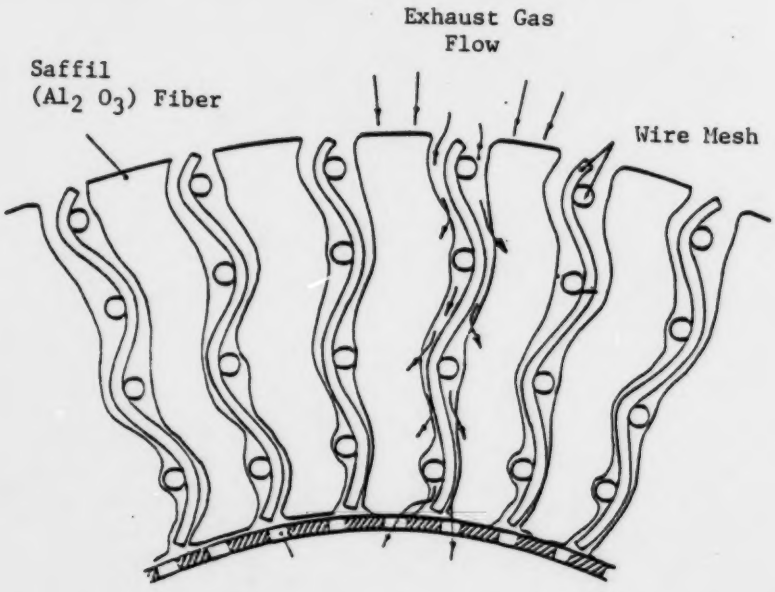


Figure 5

Cross Section of the Filter
in the ICI Particulate Trap

Following the regeneration, both the EGBP and the trapping efficiency returned to close to the zero-mile values. After 300 miles, the EGBP had again doubled and the TP emissions were approaching the baseline values. The trap was again regenerated by throttling, and again both the EGBP and TP returned to close to the zero-mile values.

Those two regenerations did not appear to help either the fuel economy or the FTP NOx emissions, both of which continued to deteriorate slightly during the 1,300 miles accumulated on this trap.

Additional tests were performed, and sulfate data were taken. Those data appear in the following table:

Test Cycle	TP(g/mi)	SO_4(g/mi)	% SO_4
Cold Start LA-4 Bag 1	1.010	.039	3.86%
Cold Start LA-4 Bag 2	.727	.2267	31.2%
Hot Start LA-4 Bag 1	.865	.0456	5.27%
Hot Start LA-4 Bag 2	.884	.0130	1.47%
HWFE	.602	.0797	13.2%
HWFE	.591	.0539	9.12%

The above data indicate that sulfates are not a major problem for this catalyzed trap.

The results of the Ames tests performed on the TP basically showed normal Diesel particulate reactivity.

One of the important questions concerning "regeneration techniques" is that of vehicle emissions during the regeneration. Because the ICI-Saffil Trap had demonstrated good regenerative capabilities in the past, it was decided to load up the trap and sample the vehicle emissions during the regenerative cycle. The previous regenerations had indicated that the following cycle successfully regenerated the trap:

1) Steady State 60 mph until temperature stabilization,

2) Throttled Inlet at 9.0" Hg Vacuum for 8 minutes at 60 MPH,

3) Unthrottled Inlet for 4 minutes at 60 MPH.

To sample the regeneration, one set of exhaust CVS bags was taken during the throttled 8 minute period and one bag during the 4 minute unthrottled period. Corresponding particulate filters were also taken.

Prior to running the ICI regeneration sampling attempt, the cycle was run on the test vehicle with the "dummy trap" (an empty trap container) installed (on October 15 & 16, 1979). This would give us baseline values to determine the results of the regeneration.

The ICI trap was then installed and put on LA-4 mileage accumulation. The first mileage loading was quite light and resulted in only about 10" H_2O increase in EGBP. A regeneration was attempted on 10-19-79 using the cycle described above. A small decrease in EGBP was noted. The vehicle was returned to mileage accumulation and loaded to a 60 mph EGBP of 62.9" H_2O. The regeneration cycle was again attempted. This time the trap regenerated successfully, and the 60 mph EGBP was reduced to 42.8" H_2O.

In comparison to the "dummy trap" data, regeneration data indicate that:

1) Hydrocarbons remain about the same,

2) CO rises significantly but is still quite low in absolute numbers,

3) NOx is slightly reduced,

4) Fuel economy was not noticeably affected, and

5) Particulate emissions were down 42% during the throttled cycle and 12% during the unthrottled cycle.

These results clearly indicate that, for this vehicle/trap combination, the regeneration cycle is successfully oxidizing the particulate, not just blowing the particulates out of the trap and into the atmosphere. The emission results indicate that there is no significant emission penalty in running a regeneration cycle. These results indicate that on this vehicle and with this trap, using FTP and HFET cycles to evaluate total emissions, including particulate, is sufficient and a "regeneration test" procedure may not be needed to evaluate emissions during regeneration.

The other result of this testing series was the continued capability of the ICI trap to successfully regenerate. The low mileage trap has been regenerated five times and has accumulated over 1750 miles. The low mileage data indicate that the ICI trap has the potential for satisfactory durability.

8. ICI Saffil Fourth Generation Trap:

A second ICI Saffil trap, with increased density of the Saffil fibers compared to the first ICI trap, was installed and tested on the Mercedes from October, 1980 through April, 1981 and then was later installed and tested on the Toyota during September and October of 1981.

When this trap was tested on the Mercedes, the FTP TP emissions actually increased over the baseline values. (Even if the one questionable test were ignored, the FTP TP emissions with the trap exceed the average TP emission from the five dummy (i.e. baseline) tests. The trap was then baked at 1000°F for two hours and installed on the Toyota.

When tested on the Toyota, this trap produced a reduction of FTP TP of only 27.8%. However, the EGBP at 60 mph never exceeded 27.1" compared to a baseline of 12.5".

A phenomenon associated with this trap is that the baseline TP emissions of both vehicles increased after this trap was tested. After several more tests, the baseline returned to normal. This happened with both

vehicles when tested with the ICI Saffil fourth generation trap. Since only the TP emissions were affected (i.e., all other measured parameters, HC, CO, NOx, CO_2, and fuel economy, all returned immediately to their respective baseline values), it is likely that small amounts of trap material were deposited in the exhaust system and were later deposited on the particulate collection filters.

9. Corning EX-40 6" Non-catalyzed Trap:

The Corning EX-40 (non-catalyzed) trap is a cellular ceramic honeycomb with porous walls which act as the filter medium. The filter concept involves blocking alternate cell channel openings on the monolith face in a checkerboard type fashion as seen in Figure 6. The opposite end is similarly blocked but one cell displaced so that the gas cannot flow directly through a given channel. The exhaust gas enters the upstream open end of the cells. Since the downstream end of the cell is blocked with a ceramic plug, the exhaust gas is forced through the porous wall to exit through an adjacent cell, as shown in Figure 7. (5)

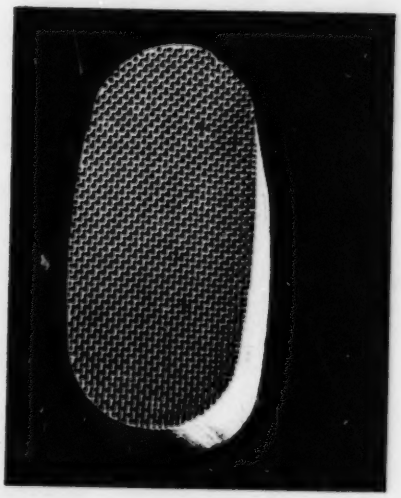


Figure 6

Monolith Face of a
Typical Corning Trap(5)

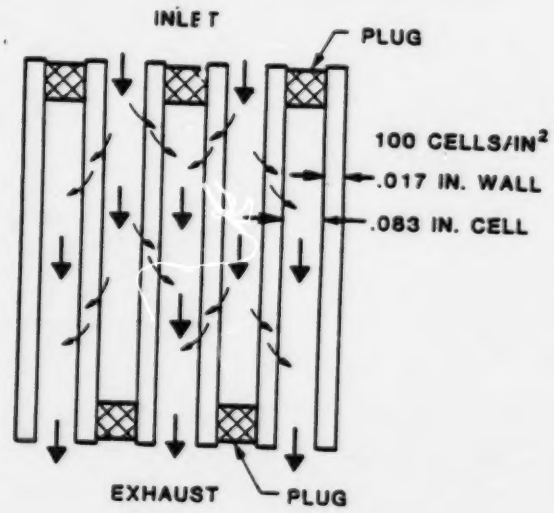


Figure 7

Particulate Trapping Concept Used
in the Corning and NGK-Locke Traps (6)

The trap tested by EPA was 6 inches long by 5.66 inches in diameter (called a 6 by 6). The length of the trap is quite easily extended.

The trap was installed on the Mercedes, and EGBP readings were taken after 7.5 miles of accumulation. The high EGBP readings shown below indicated that the 12 inch version might yield comparable efficiencies but at lower EGBP, so after one test sequence the trap was removed. (Full scale on the EGBP measurement system was 73.2 inches of water.)

	EGBP (in inches of water)			
Odometer	30 mph	40 mph	50 mph	60 mph
34,907		43.85	59.76	over 73.2
34,914		54.44	73.14	over 73.2
34,962		68.52	over 73.2	over 73.2
34,982	54.15	over 73.2	over 73.2	over 73.2

The single set of emission results indicates a significant reduction in both HC and TP emissions.

10. Corning EX-47 6" Non-catalyzed Trap:

The Corning EX-47 trap is the same design and size as the EX-40 trap but with increased porosity. The increased porosity was supposed to decrease the EGBP penalty without sacrificing the high trapping efficiency of the EX-40 trap. However, when this trap was installed on the Mercedes and the EGBP measured, it was found to exceed (at "zero-mile") 105 inches of water at 60 mph. (The range of the EGBP measurement system had been extended from 73.2 to 105 inches of water.) Thus, only the "zero-mile" emissions were measured.

Based on only the "zero-mile" data, the EX-47 trap, like the EX-40, showed a significant reduction (over 60%) in TP emissions as well as a moderate reduction in HC emissions.

11. Englehard CST-1 Coating of a Corning EX-47 6" Trap:

A second EX-47 6-inch trap was sent to Englehard where the same CST-1 catalyst used on the Texaco trap was applied. The trap was installed on the Mercedes and testing began in January, 1980. The EGBP was acceptable at "zero-mile" but rose very rapidly (from 53.2 to 91.67 inches of water at 50 mph during the first 125 miles). A regeneration was attempted but no reduction in EGBP was noted.

Based on only the "zero-mile" data, this trap exhibited signficant reductions (over 60%) in HC, CO, and FTP TP. However, the HWFE TP had increased above its baseline values. The trap was removed to allow testing of the 12 inch EX-47 traps.

12. Corning EX-47 12" Non-catalyzed Trap:

The Corning EX-47 12" trap has the same diameter (5.66 inches) but is twice as long as the EX-47 6" traps. The trap was installed on the Mercedes, and testing began on February 12, 1980.

After the EGBP rose by a factor of 4 (from 25.56 to 101.1 inches of water at 50 mph), the trap was successfully regenerated. The trapping efficiency and EGBP returned to zero mile values. The trap was tested and loaded a second time and again successfully regenerated.

Upon completion of that second regeneration, mileage was accumulated on the trap without running HWFE cycles. The mileage accumulation would consist of FTP and LA-4 tests. When either performance or fuel economy became so degraded that a driver would notice a problem existed, an attempt to regenerate the trap would be made. This testing sequence continued until after 456 miles the 60 mph EGBP was above 365" H_2O (compared to a "zero-mile" value of 36.7 inches of water at 60 mph and driveability of the vehicle was noticeably affected. The test vehicle would not idle and often stalled.

The trap was then regenerated. The test vehicle with some difficulty was accelerated to 60 mph steady state speed to achieve temperature stabilization. The trap began to regenerate itself without throttling. The 60 mph steady state EGBP dropped from about 365" H_2O to about 230" H_2O without throttling. The inlet manifold vacuum was then set to 9" Hg and the regular regeneration sequence commenced. Bag and particulate samples were taken for the 8 minute throttled portion and for the following 4 minute unthrottled portion. An additional reduction in EGBP was noted when the regeneration cycle was rerun. The trap outlet temperature rose very quickly when the throttling was first performed. The temperature difference between trap inlet and outlet indicated significant particulate exothermic oxidation. The EGBP returned to zero-mile values. The final FTP, HFET, and LA-4 test data indicated reduced trapping efficiency. This indicated that high temperature experienced during the regeneration and/or that the high back pressure noted during the mileage accumulation may have damaged the trap.

The results of the EX-47 12 inch non-catalyzed trap testing are impressive. The regeneration interval of 200+ miles and the high (65%+) trapping efficiency show a good combination of measured performance parameters. The testing with the trap extremely loaded indicated that the trap would either regenerate or cause the vehicle to perform so poorly that a driver would recognize that a problem existed.

Durability of the ceramic style trap has not been evaluted. During the 889 miles of testing, the trap performed well.

13. UOP Coating of a Corning EX-47 12 inch Trap:

A second Corning EX-47 12 inch trap was coated by Universal Oil Products Inc. (UOP). The catalytic washcoat used was identified as PZM-10171-01031138. Further details were not provided by UOP.

The trap was installed on the Mercedes, and testing began on April 17, 1981. However, it was removed after concerns were voiced over whether

the test vehicle was still stable. (Baseline testing indicated a significant increase in FTP TP emissions in the test vehicle between October, 1980 and April, 1981.)

Additional baseline (i.e. with the dummy trap) testing indicated that the Mercedes was stable.

Testing of the UOP EX-47 trap resumed on September 1, 1981. The emission data indicated significant reductions in HC, CO, and FTP TP; however, the HWFE TP exceeded the baseline values.

The EGBP (at 60 mph) increased from its "zero-mile" value of 35.3 inches of water to 121.4 inches after 414 miles, at which time the trap was regenerated using a 16 minute, 60 mph steady state, throttling process. The EGBP returned to close to its "zero-mile" value (45.9" of water at 60 mph). After 100 miles, the EGBP had risen to 102.002 inches of water at 60 MPH, the trap was successfully regenerated for a second time, and the EGBP was measured at 39.65 inches at 60 mph. The EGBP again began to increase as mileage was accumulated until October 28, 1981 (at an odometer reading of 42,802) the pressure began to drop. After performing an FTP the next day, the trap was examined and found to have a radial crack 2/3 of the way down the trap which split the unit into two pieces. Testing was terminated.

14. NGK #1 Trap:

NGK-Locke, Inc. provided a cellular, ceramic, monolith trap which, like the traps submitted by Corning, employs filtration through porous walls. The specifications of this trap (designated DHC-101) are:

Length:	12 inches
Diameter:	5.66 inches
Cell Structure:	200 cells per square inch
Wall Thickness	0.012 inches

The trap was installed on the Toyota, and testing began in October, 1981.

The "zero-mile" data indicated good efficiency and low EGBP (only 25.46 inches of water at 60 mph compared to the baseline of 11.5 to 12.2 inches). After accumulating 1082 kilometers (672 miles), the EGBP had increased to 119.3 inches at 60 mph, but the trapping efficiency on the FTP had also increased to 82%.

After regeneration, the EGBP decreased to 30.0 inches, close to its "zero-mile" value, and the efficiency dropped to 63%. After accumulating an additional 708 kilometers (440 miles), the EGBP had increased to 108.2 inches, and the efficiency increased to 82% again.

The trap was then regenerated again, the EGBP dropped to 21.7 inches, and the efficiency dropped to 43%. After accumulating an additional 830 kilometers (516 Miles), the EGBP increased to 88.4 inches, and the efficiency increased to 49%.

The trap was then regenerated (for a third time), the EGBP dropped to 32.25 inches, and the efficiency increased to 70%.

The trap is averaging more than 60% efficiency in reducing FTP TP, and more than 75% efficiency in reducing HWFE TP. Also, the trap is averaging 771 kilometers (479 miles) between regenerations.

15. NGK #2 Trap:

NGK-Locke, Inc. provided a second trap identical to their first except that this trap has only 100 cells per square inch with a wall thickness of 0.017 inches. The trap was installed on the Mercedes, and testing began in November, 1981.

The test results are similar to the NGK #1 trap except:

1. The "zero-mile" EGBP is higher (38.10 inches at 60 mph),

2. The EGBP dropped to 78.2, 70.38, and 56.3 inches at 60 mph after the first three regenerations,

3. The distance between regenerations is averaging 185 kilometers (115 miles), and

4. The trapping efficiencies are averaging 87% on both FTP and HWFE.

SUMMARY

A summary of the advantages and disadvantages of each of the traps follows in Table 5.

The possibility that the trap-oxidizer might affect fuel economy has been of some concern.(14) To examine this possibility, graphs of fuel economy, trapping efficiency, and EGBP versus mileage accumulation were plotted. (See Figures 8 to 15.) These graphs indicate that there is a tendency for a loss of fuel economy as EGBP increases; however, the data (Appendix A) indicate that the overall (i.e. arithmetic mean) fuel economy with the trap is not significantly different from the fuel economy without the trap (i.e. with the "dummy" trap).

Even though this test program is not complete, we can select the best traps from among those already tested. Based on trapping efficiency (on both FTP and HWFE) together with regeneration capabilities (either on the HWFE cycle or on the regeneration cycle used in this program), the "best" traps tested to date in this program are the 12 inch, non-catalyzed, monolith traps (i.e. Corning EX-47, NGK #1, and NGK #2).

TABLE 5

SUMMMARY OF ADVANTAGES AND DISADVANTAGES OF TRAPS USED IN IN-HOUSE TEST PROGRAM THROUGH JANUARY 21, 1982

TRAP	ADVANTAGES	DISADVANTAGES
Texaco A-1R	1. Good initial efficiency 2. Relatively low EGBP 3. Good adaptability to catalyst coáting	1. Questionable regen. capabilities 2. Large & heavy 3. Not available in quantity before 1984
Texaco A-1R (#1 & #2) with CST-1 coating	1. Very slow EGBP rise 2. Regenerates on HWFE 3. Extremely low gaseous HC & CO results 4. Extremely low extractable organics rate	1. Low total trapping efficiency 2. Increased sulfate output 3. Large & heavy
Balston filter (disposable trap)	1. Very high initial effic.	1. No regen. capabilities 2. Lack durability data (test trap failed)
Johnson-Matthey JM-4 (#1 & #2)	1. Large HC & CO reductions 2. Acceptable EGBP penalty 3. Regenerates on HWFE 4. High initial FTP efficiency	1. Increased sulfate emissions
ICI Saffil	1. Proven regen. capability 2. Acceptable EGBP drop 3. Good noise suppression 4. Good catalyst capabilities	1. Large & heavy 2. Questionable durability 3. Poor initial trapping efficiency
ICI Saffil Generation #4	1. Very low EGBP	1. Low efficiency

TABLE 5 (CONT.)

SUMMMARY OF ADVANTAGES AND DISADVANTAGES OF TRAPS USED IN IN-HOUSE TEST PROGRAM THROUGH JANUARY 21, 1982

TRAP	ADVANTAGES	DISADVANTAGES
Corning EX-40	1. High efficiency	1. High EGBP
Corning EX-47 6" non-catalyzed	1. High trapping efficiency 2. Moderate HC & CO reduction	1. High EGBP 2. Limited range (expect about 100 Mi between regen.)
Corning EX-47 6" with CST-1 Coating	1. High initial efficiency 2. Large HC & CO reduction	1. High EGBP 2. Limited range between regen. 3. Suspected increased sulfate emissions 4. Poor regen. capabilities
Corning EX-47 12" non-catalyzed	1. High efficiency 2. Proven regen. capabilities	1. May be damaged by worst case regen. 2. Relatively short range (200 Mi between regen.)
Corning EX-47 12" with UOP Coating	1. Large HC & CO reduction 2. Good regen. capabilities	1. Relatively short range (160 Mi between regen.)
NGK #1 (high density, 200 cpsi)	1. High efficiency 2. Moderate EGBP increase 3. Good range capabilities (480 Mi between regen.)	
NGK #2 (normal density, 100 cpsi)	1. High efficiency	1. Rapid EGBP rise after regen. 2. Relatively short range (115 Mi between regen.)

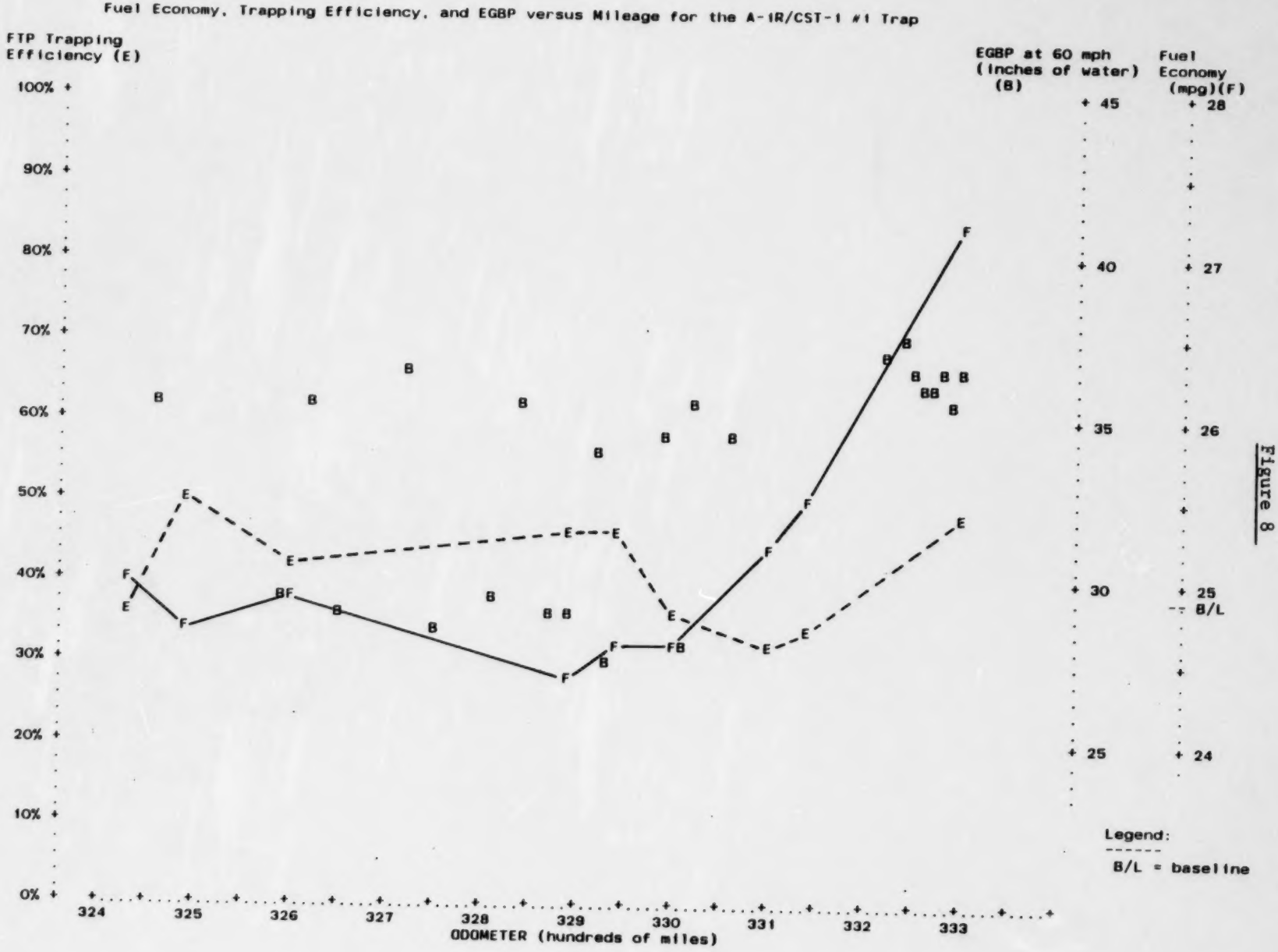

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the A-1R/CST-1 #1 Trap
FTP Trapping Efficiency (E)
EGBP at 60 mph (inches of water) (B)
Fuel Economy (mpg)(F)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
45
40
35
30
25
28
27
26
25
24
B/L
324
325
326
327
328
329
330
331
332
333
ODOMETER (hundreds of miles)
Legend:
B/L = baseline

Figure 8

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the A-1R/CST-1 #2 Trap

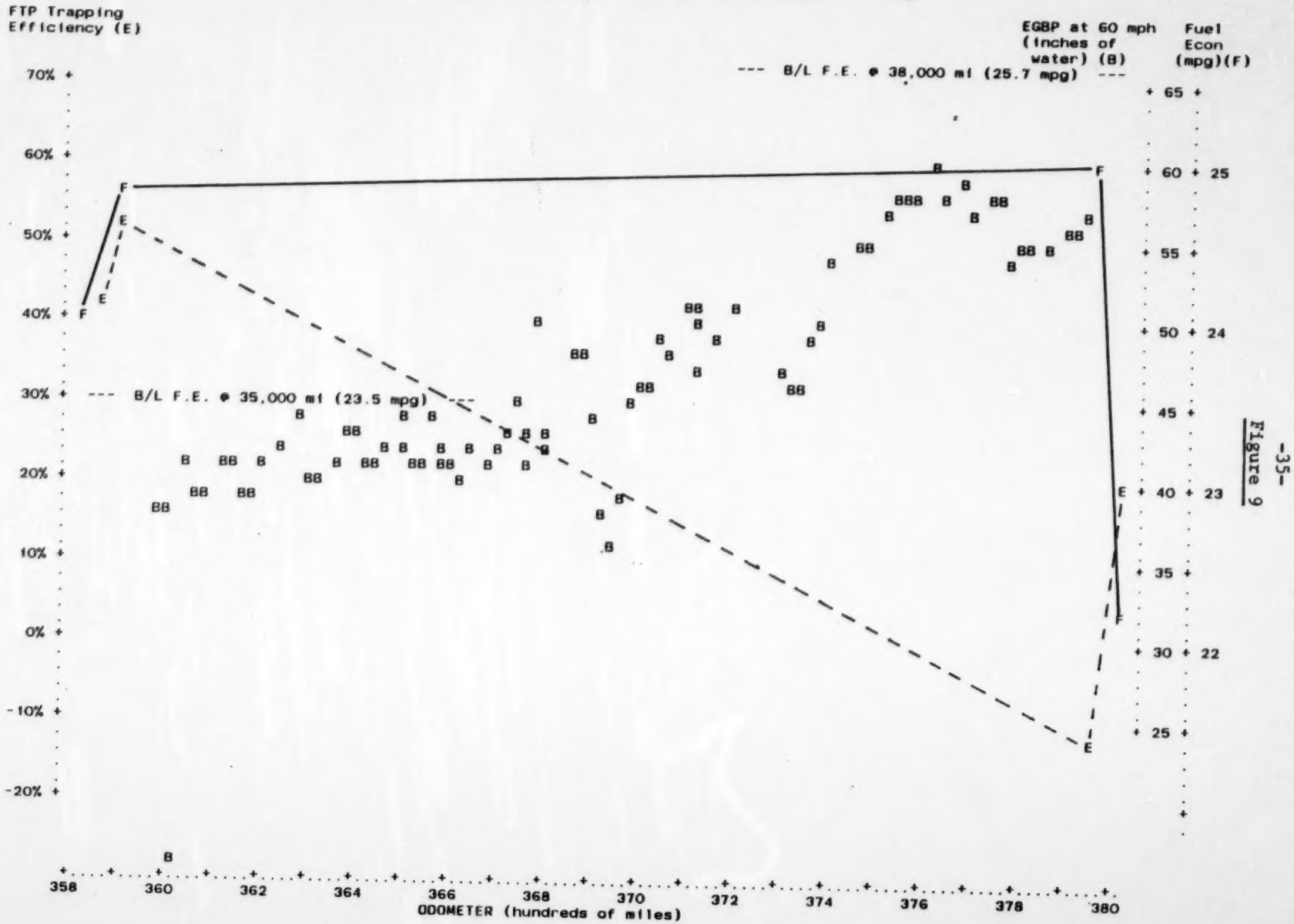


Figure 9

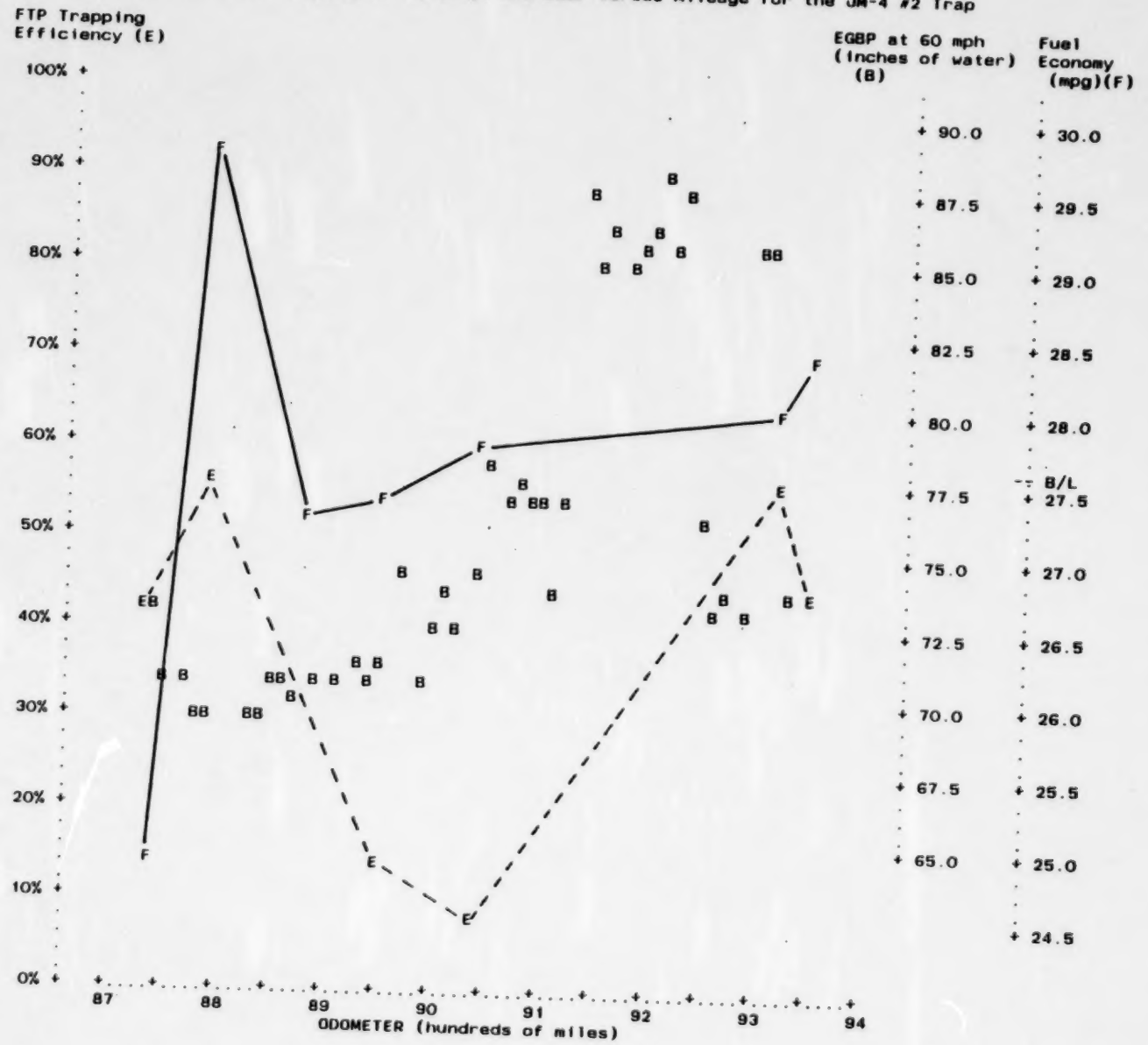
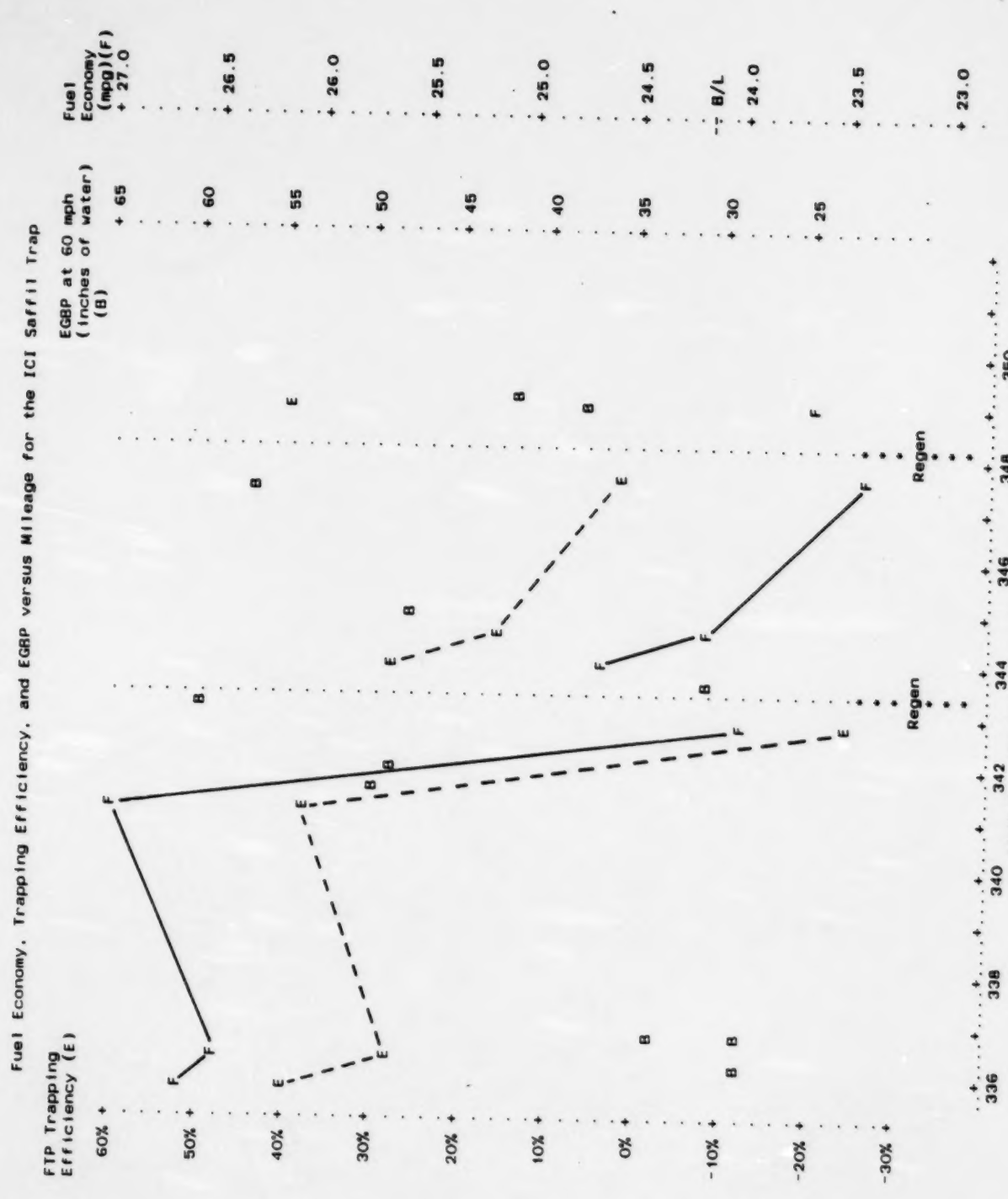

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the JM-4 #2 Trap
FTP Trapping Efficiency (E)
EGBP at 60 mph (inches of water) (B)
Fuel Economy (mpg)(F)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
30.0
29.5
29.0
28.5
28.0
B/L
27.5
27.0
26.5
26.0
25.5
25.0
24.5
87
88
89
90
91
92
93
94
ODOMETER (hundreds of miles)

Figure 10

Figure 11


Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the ICI Saffil Trap
FTP Trapping Efficiency (E)
EGBP at 60 mph (inches of water) (B)
Fuel Economy (mpg)(F)
B/L
ODOMETER (hundreds of miles)
Regen
Regen

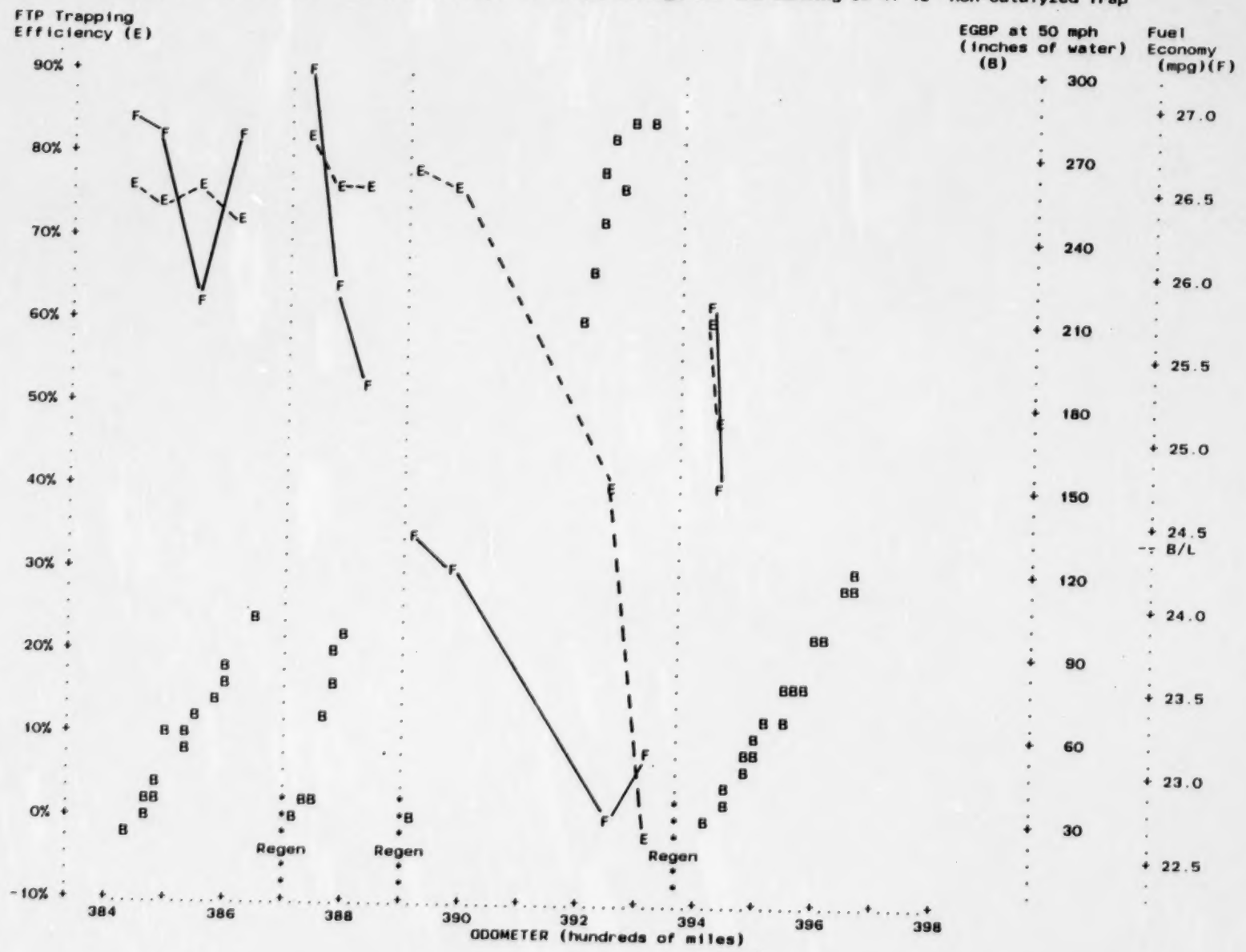

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the Corning EX-47 12" non-catalyzed Trap
FTP Trapping Efficiency (E)
EGBP at 50 mph (inches of water) (B)
Fuel Economy (mpg)(F)
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
300
270
240
210
180
150
120
90
60
30
27.0
26.5
26.0
25.5
25.0
24.5
B/L
24.0
23.5
23.0
22.5
Regen
Regen
Regen
384
386
388
390
392
394
396
398
ODOMETER (hundreds of miles)

Figure 12

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the UOP/Corning EX-47 Trap

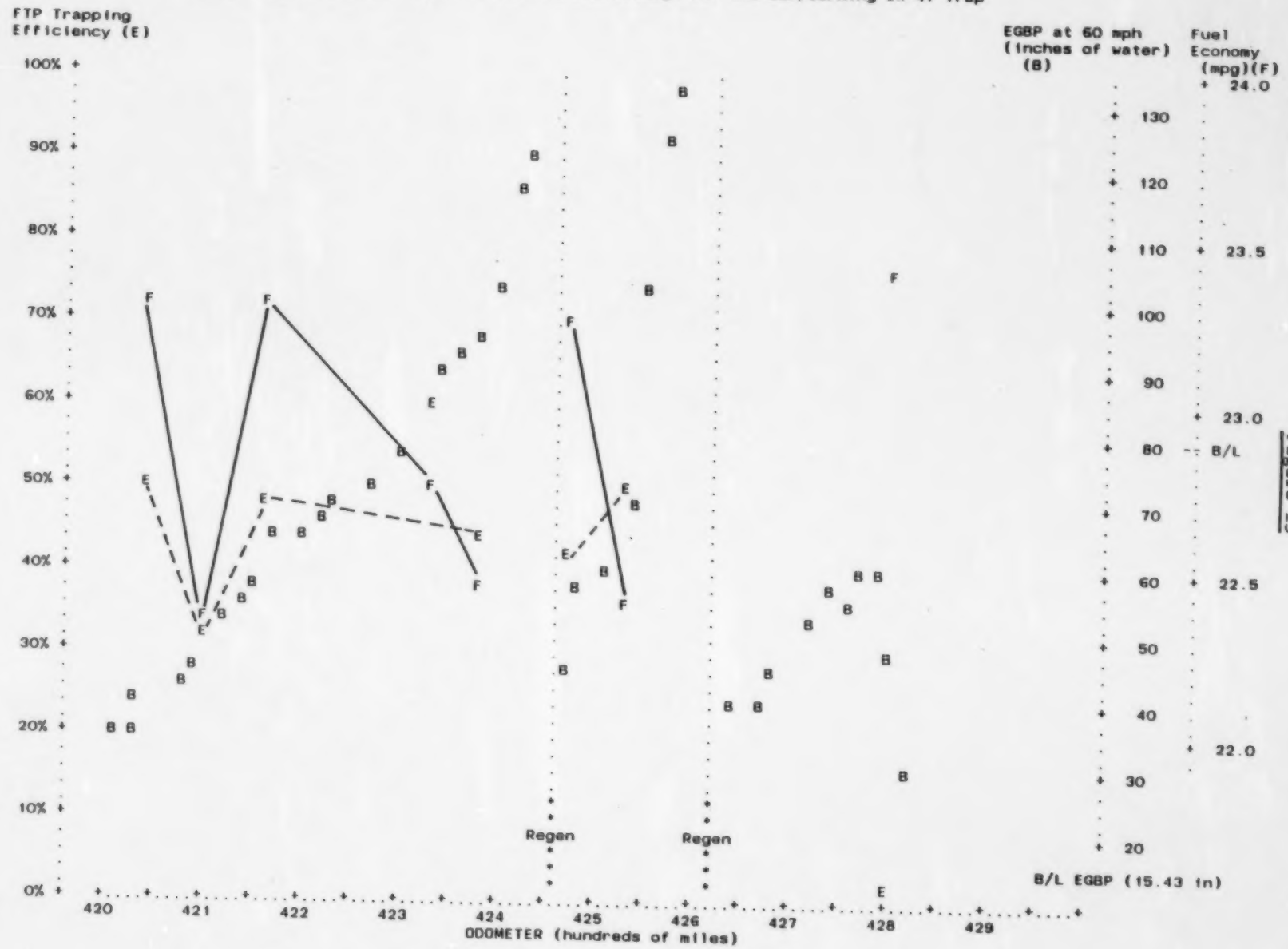


Figure 13

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the NGK #1 Trap

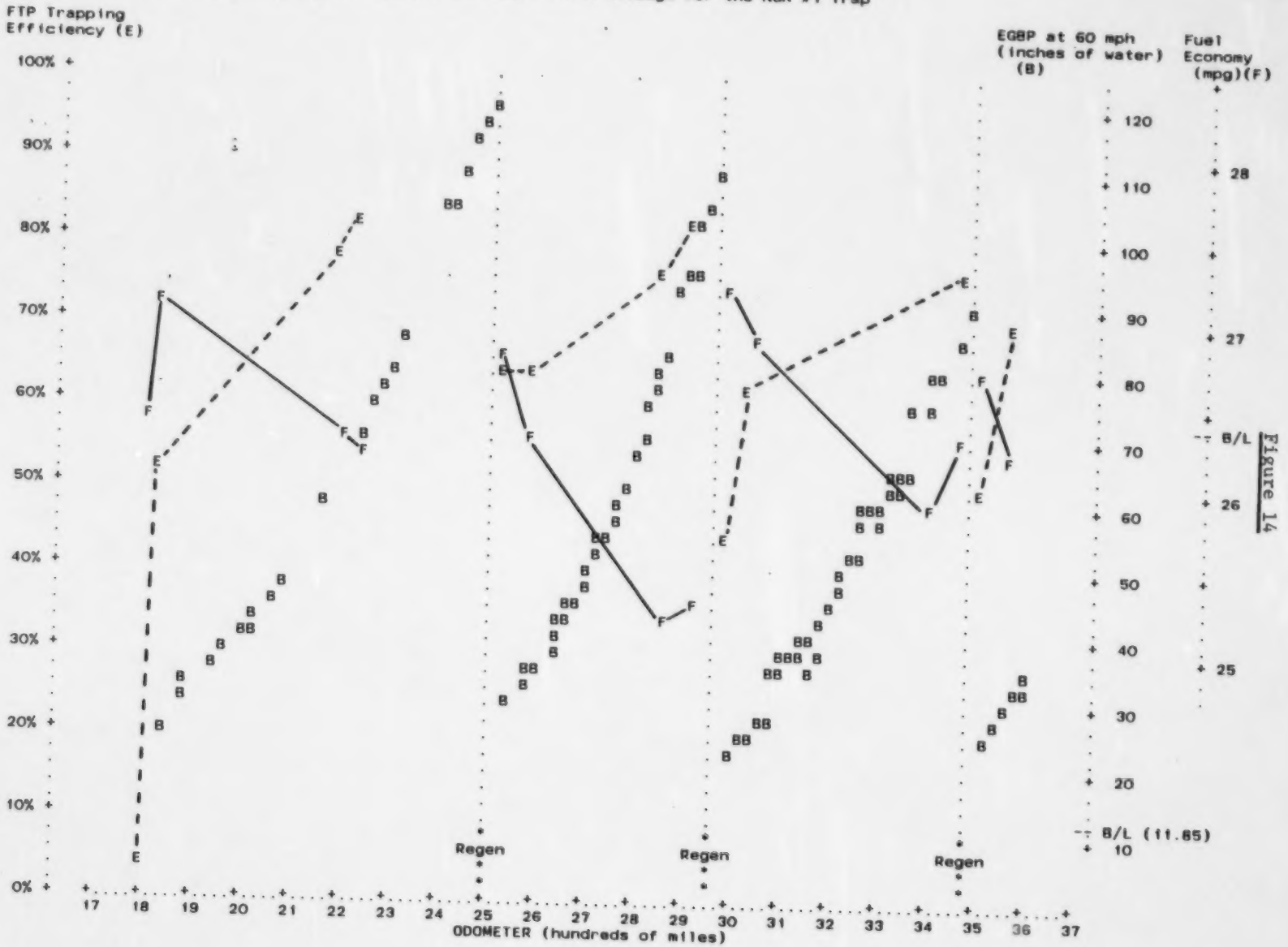


Figure 14

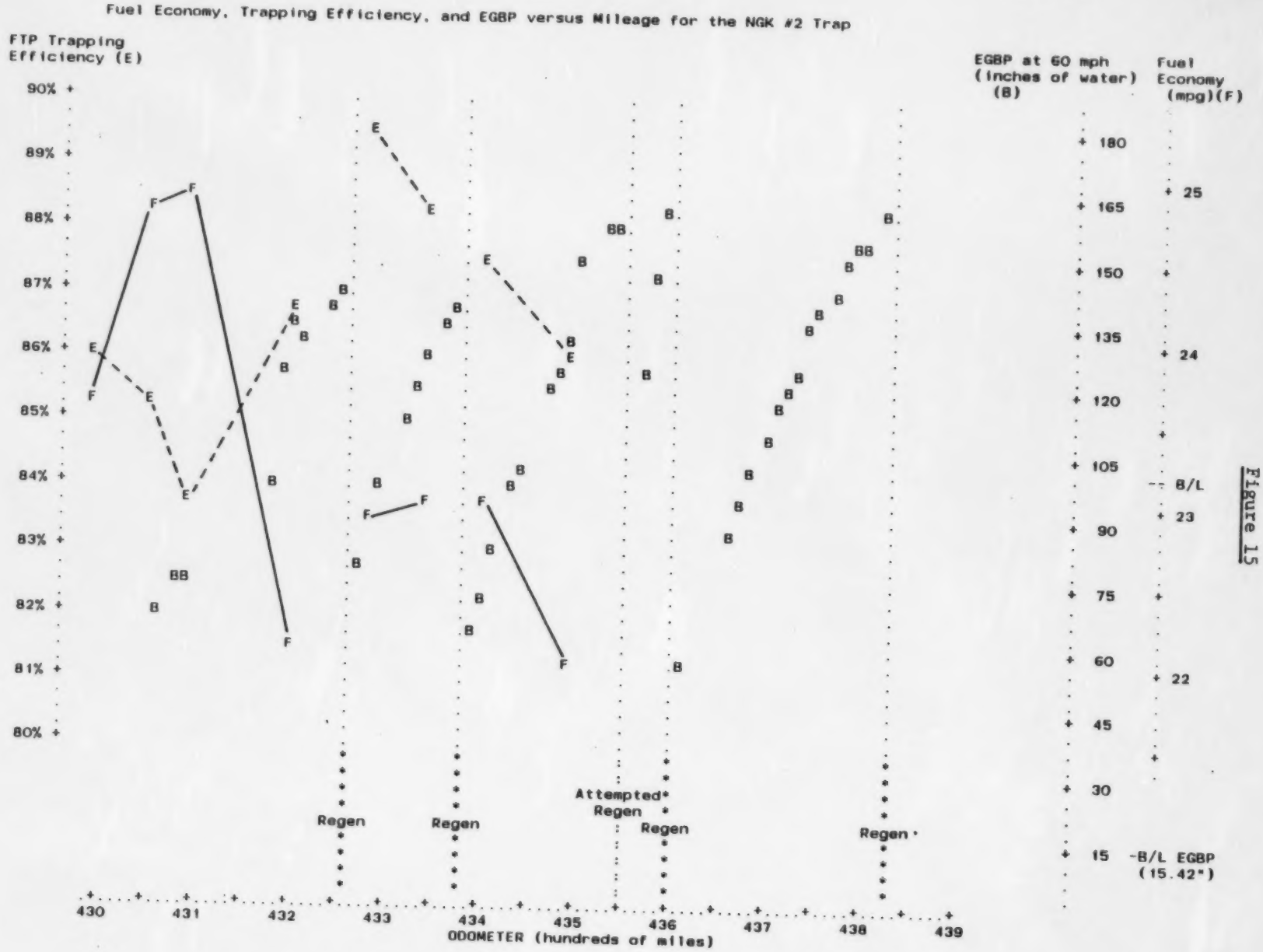

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the NGK #2 Trap
FTP Trapping Efficiency (E)
90%
89%
88%
87%
86%
85%
84%
83%
82%
81%
80%
EGBP at 60 mph (inches of water) (B)
180
165
150
135
120
105
90
75
60
45
30
15
Fuel Economy (mpg)(F)
25
24
23
22
B/L
-B/L EGBP (15.42")
Regen
Regen
Attempted Regen
Regen
Regen
430
431
432
433
434
435
436
437
438
439
ODOMETER (hundreds of miles)

Figure 15

References

1. K. Otto, et al, "The Oxidation of Soot Deposits from Diesel Engines," SAE Paper No. 800336, February 1980.

2. L. P. Tessier, et al, "The Development of a High Efficiency Diesel Exhaust Particulate Filter," SAE Paper No. 800338, February 1980.

3. M. J. Murphy, et al, "Assessment of Diesel Particulate Control - Direct and Catalytic Oxidation," SAE Paper No. 810112, February 1981.

4. S. H. OH, et al, "Mathematical Modeling of Fibrous Filters for Diesel Particulates - Theory and Experiment," SAE Paper No. 810113, February 1981.

5. J. S. Howitt and M. R. Montierth, "Cellular Ceramic Diesel Particulate Filter," SAE Paper No. 810114, February 1981.

6. W. R. Wade, "Diesel Particulate Trap Regeneration Techniques," SAE Paper No. 810118, February 1981.

7. M. J. Murphy, et al, "Assessment of Diesel Particulate Control: Direct and Catalytic Oxidation," EPA Report No. 600/7-79-232b prepared by Battelle Columbus Laboratories, October 1979.

8. "Diesel Particulate Trap Study: Interim Report on Status of Study and Effects of Throttling," EPA Memorandum from T. Penninga to R. Stahman, dated May 18, 1979.

9. "Second Interim Report on Status of Particulate Trap Study," EPA Memorandum from T. Penninga to R. Stahman, dated August 18, 1979.

10. "Third Interim Report on Status of Particulate Trap Study," EPA Memorandum from T. Penninga to R. Stahman, dated November 6, 1979.

11. "Correction of EGBP in Interim Diesel Particulate Trap Reports," EPA Memorandum from T. Penninga to R. Stahman, dated December 18, 1979.

12. "Fourth Interim Report on Status of Particulate Trap Study," EPA Memorandum from T. Penninga to R. Stahman, dated May 27, 1980.

13. "Further Testing of the Johnson-Matthey JM-4#2 Diesel Particulate Trap," EPA Memorandum from T. Penninga to R. Stahman, dated July 25, 1980.

14. "Studies of 1984 Heavy-Duty Engine and 1985 Light-Duty Diesel Vehicle Requirements and Emissions Performance and Defect Warranties," Federal Register, 46 FR 31677, June 17, 1981.

15. "Characterization of Gaseous and Particulate Emissions from Light-Duty Diesels Operated on Various Fuels," EPA Report Number EPA-460/3-79-008, July 1979.

16. L.D. Claxton, "The Utility of Bacterial Mutagenesis Testing in the Characterization of Mobile Source Emissions: A Review," presented at the Environmental Protection Agency 1981 Diesel Emissions Symposium, Raleigh, North Carolina, October 5-7, 1981.

17. R.B. Zweidinger, "Emission Factors from Diesel and Gasoline Powered Vehicles: Correlation with the Ames Test," presented at the Environmental Protection Agency 1981 Diesel Emissions Symposium, Raleigh, North Carolina, October 5-7, 1981.

18. "Explanations and Presentations of Ames Test Data," EPA Memorandum from R. Dickinson to C. Gray, dated March 4, 1981.

Appendix A-1

Test Data on Mercedes 300D

VEHICLE I.D. 11511412Q19885 (1975 MERCEDES BENZ 300D)

TEST NUMBER	TEST DATE	ODOM (MI)	TEST CYCLE	EMMISIONS (G/MI) HC	CO	NOx	TP	F.E. (mpg)	TRAP TYPE
797304	03-22-79	29494	FTP	.77868	.8877	2.0041	.504	23.8482	Baseline
797303	03-23-79	29532	FTP	.36699	.9112	2.0478	.404	24.2037	Baseline
797305	03-23-79	29543	HWFE	.16229	.5749	2.0367	.306	29.3019	Baseline
MEAN (COUNT):			FTP (2)	.57284	.8994	2.0260	.454	24.0260	
STANDARD DEVIATION:				.29111	.0166	.0309	.071	.2514	
MEAN (COUNT):			HWFE(1)	.16229	.5749	2.0367	.306	29.3019	
797036	03-30-79	29755	FTP	.25759	.9111	2.3367	.464	24.3978	45 degree SwRI elbow
797040	03-30-79	29767	HWFE	.10726	.5957	.8852	.327	28.6537	45 degree SwRI elbow
797431	04-03-79	29794	FTP	.27247	.9943	1.9380	.535	23.8729	45 degree SwRI elbow
797432	04-03-79	29805	HWFE	.08971	.5422	1.9870	.360	28.1109	45 degree SwRI elbow
MEAN (COUNT):			FTP (2)	.26503	.9527	2.1374	.500	24.1354	
STANDARD DEVIATION:				.01052	.0588	.2819	.050	.3712	
MEAN (COUNT):			HWFE(2)	.09848	.5690	1.4361	.344	28.3823	
STANDARD DEVIATION:				.01241	.0378	.7791	.023	.3838	
797443	04-10-79	30347	FTP	.31306	1.0261	1.8594	.531	24.2028	Dummy Trap
797444	04-10-79	30366	HWFE	.04483	.5535	1.7893	.369	29.9401	Dummy Trap
797447	04-25-79	30637	FTP	.27529	.9377	1.9666	N/R	23.9334	Dummy Trap
797448	04-25-79	30658	HWFE	.11450	.5846	1.7922	.336	28.9796	Dummy Trap
797449	04-26-79	30671	FTP	N/R	.9615	1.8898	.537	24.3007	Dummy Trap
797450	04-26-79	30692	HWFE	N/R	.5659	1.7711	.349	29.2494	Dummy Trap
797451	04-27-79	30704	FTP	.24918	.9373	1.8949	.414	24.6332	Dummy Trap
797452	04-27-79	30725	HWFE	.08917	.5658	1.7350	.302	29.5781	Dummy Trap
797453	04-30-79	30745	FTP	.24071	.9370	1.8942	.497	24.5753	Dummy Trap
797454	04-30-79	30766	HWFE	.08770	.5553	1.7515	.330	29.7529	Dummy Trap
797629	05-01-79	30779	FTP	.25940	.9645	1.9236	.531	23.6558	Dummy Trap
797630	05-01-79	30800	HWFE	.09270	.5515	.9306*	.346	28.5026	Dummy Trap
797631	05-02-79	30813	FTP	.27772	.9342	1.9181	.528	23.9896	Dummy Trap
797632	05-02-79	30834	HWFE	.09586	.5640	1.8420	.355	28.6606	Dummy Trap
797637	05-04-79	30880	FTP	.30600	.9525	1.9469	.427	23.7590	Dummy Trap
797638	05-04-79	30890	HWFE	.09840	.5619	1.8238	.301	28.3411	Dummy Trap
797639	05-07-79	30921	FTP	.27162	.6931*	1.5265*	.420	31.4244*	Dummy Trap
797640	05-07-79	30942	HWFE	.10588	.5269	1.8893	.303	28.5022	Dummy Trap
MEAN (COUNT):			FTP	.27412(8)	.9271(9)	1.8689(9)	.486(8)	24.9416(9)	
STANDARD DEVIATION:				.02538	.0923	.1324	.055	2.4543	

Old trap; used for developing regeneration techniques.

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* Questionable data

MEAN (COUNT):			HWFE	.09113(8)	.5588(9)	1.7028(9)	.332(9)	29.0563(9)	
STANDARD DEVIATION:				.02070	.0155	.2934	.025	.5983	
797643	05-10-79	30983	FTP	.10615	.9266	1.9128	.213	24.0779	Texaco A-1R
797644	05-10-79	31004	HWFE	.04061	.5602	1.8372	.133	29.1683	Texaco A-1R
797647	05-11-79	31042	FTP	.11003	.8824	1.8950	.182	24.2533	Texaco A-1R
797648	05-11-79	31063	HWFE	.05566	.5426	1.8469	.133	29.2503	Texaco A-1R
797646	05-15-79	31203	HWFE	.07688	.5528	1.7781	.121	30.1082	Texaco A-1R
797790	05-16-79	31282	HWFE	.06309	.5982	1.9414	.164	27.7278	Texaco A-1R
797792	05-17-79	31316	FTP	.12335	.9327	1.9220	.203	23.9047	Texaco A-1R
797793	05-17-79	31337	HWFE	.06017	.5822	1.9357	.151	28.0359	Texaco A-1R
797795	05-18-79	31384	FTP	.13012	.8390	1.9023	.274	24.1959	Texaco A-1R
797796	05-18-79	31404	HWFE	N/R	N/R	N/R	.173	29.5857	Texaco A-1R
797798	05-21-79	31440	FTP	.15114	.9293	1.8870	.277	24.2994	Texaco A-1R
797799	05-21-79	31457	HWFE	.05878	.5917	1.9062	.174	28.5861	Texaco A-1R
797801	05-22-79	31501	FTP	.14106	.9742	1.9677	.297	23.7862	Texaco A-1R
797802	05-22-79	31519	HWFE	.04430	.5487	1.8251	.189	30.0292	Texaco A-1R
796946	05-23-79	31587	HWFE	.06476	.6205	1.8582	.187	28.3422	Texaco A-1R
797030	06-05-79	31711	FTP	.16372	.9378	1.9719	.344	23.4565	Texaco A-1R
797031	06-05-79	31733	HWFE	.07104	.6022	1.8537	.200	28.9063	Texaco A-1R
none		31842	STEADY STATE						REGENERATION
797035	06-08-79	31901	FTP	.13622	.9140	1.9333	.221	24.1307	Texaco A-1R
797869	06-08-79	31922	HWFE	.04742	.5581	1.8043	.140	29.3348	Texaco A-1R
none	06-10-79	31962	STEADY STATE						REGENERATION
797871	06-11-79	31969	FTP	.16208	.9036	1.9542	.228	24.1269	Texaco A-1R
797872	06-11-79	31983	HWFE	.05969	.5605	1.8685	.132	28.5097	Texaco A-1R
none			RECIRCULATING OVEN @ 925°F FOR 6.5 HOURS						REGENERATION
MEAN (COUNT):			FTP (9)	.13599	.9155	1.9274	.249	24.0257	
STANDARD DEVIATION:				.02081	.0382	.0314	.052	.2682	
MEAN (COUNT):			HWFE	.05840(11)	.5743(11)	1.8596(11)	.158(12)	28.9654(12)	
STANDARD DEVIATION:				.01101	.0257	.0513	.027	.7520	

Testing terminated due to inadequate regeneration (only central core was regenerated with throttling).

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 4-10-79 THROUGH 6-26-79):

*

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

*

FTP	.4916	.9984	1.0244	.5210	.9687
HWFE	.6118	1.0451	1.0778	.4744	.9852

*

* TRAP EFFICIENCY:

*

FTP	50.8%	0.2%	-2.4%	47.9%	-3.1%
HWFE	38.8%	-4.5%	-7.8%	52.6%	-1.5%

*

797874	06-12-79	32028	FTP	.25577	.9089	1.8692	.451	24.7543	Dummy Trap
797875	06-12-79	32048	HWFE	.09287	.5416	1.8996	.311	28.4241	Dummy Trap
797877	06-13-79	32078	FTP	.24743	.8620	1.9130	.411	25.0037	Dummy Trap
797878	06-13-79	32097	HWFE	.09720	.5251	1.6987	.319	31.4068	Dummy Trap
797880	06-15-79	32130	FTP	.28628	.9149	1.9489	.511	23.9335	Dummy Trap
797881	06-15-79	32150	HWFE	.10808	.5435	1.8244	.336	28.9866	Dummy Trap
797883	06-22-79	32220	FTP	.34540	.8988	1.9398	.506	24.2665	Dummy Trap
797884	06-22-79	32241	HWFE	.11592	.5063	1.6337	.359	31.5988	Dummy Trap
797888	06-26-79	32310	FTP	.26811	.9089	1.8506	.446	24.8124	Dummy Trap
797889	06-26-79	32330	HWFE	.09771	.5475	1.7739	.352	29.6644	Dummy Trap
MEAN (COUNT):			FTP (5)	.28060	.8987	1.9043	.465	24.5541	
STANDARD DEVIATION:				.03906	.0213	.0431	.043	.4407	
MEAN (COUNT):			HWFE(5)	.10236	.5328	1.7661	.335	30.0161	
STANDARD DEVIATION:				.00942	.0171	.1041	.021	1.4280	

797893	07-02-79	32427	FTP	.02126	.0078	1.8879	.312	25.0073	Texaco A-1R w Englehard CST-1 Coating
797894	07-02-79	32448	HWFE	N/R	.0000	N/R	.260	35.0949	Texaco A-1R w Englehard CST-1 Coating
797896	07-03-79	32494	FTP	.02137	.0275	1.8948	.243	24.7020	Texaco A-1R w Englehard CST-1 Coating
797897	07-03-79	32514	HWFE	.01050	.0000	1.7450	.200	30.0265	Texaco A-1R w Englehard CST-1 Coating
798623	07-06-79	32603	FTP	.02185	.0338	1.8150	.278	24.9434	Texaco A-1R w Englehard CST-1 Coating
798624	07-06-79	32624	HWFE	.00905	.0000	1.7239	.874	29.6767	Texaco A-1R w Englehard CST-1 Coating
798621	07-09-79	32759	HWFE	.01317	.0000	1.5613	.938	32.4160	Texaco A-1R w Englehard CST-1 Coating
798627	07-10-79	32832	HWFE	N/R	.0000	N/R	.971	37.7017	Texaco A-1R w Englehard CST-1 Coating
798629	07-11-79	32893	FTP	.02661	.0334	1.8780	.265	24.4044	Texaco A-1R w Englehard CST-1 Coating
798630	07-11-79	32914	HWFE	N/R	.0000	N/R	1.136	37.4207	Texaco A-1R w Englehard CST-1 Coating
798632	07-12-79	32937	FTP	.02636	.0319	1.8845	.260	24.6408	Texaco A-1R w Englehard CST-1 Coating
798633	07-12-79	32958	HWFE	N/R	.0000	1.8611	1.040	31.4167	Texaco A-1R w Englehard CST-1 Coating
798635	07-13-79	33002	FTP	.05438	.0555	1.9286	.311	24.5739	Texaco A-1R w Englehard CST-1 Coating
798636	07-13-79	33022	HWFE	N/R	.0000	N/R	1.094	29.5889	Texaco A-1R w Englehard CST-1 Coating
798638	07-16-79	33102	FTP	.04899	.0260	1.7992	.329	25.2482	Texaco A-1R w Englehard CST-1 Coating
798639	07-16-79	33123	HWFE	N/R	.0000	1.7292	1.060	28.9995	Texaco A-1R w Englehard CST-1 Coating
798641	07-17-79	33140	FTP	.03572	.0552	1.8010	.315	25.5009	Texaco A-1R w Englehard CST-1 Coating
798642	07-17-79	33160	HWFE	N/R	.0010	1.6850	1.002	31.3807	Texaco A-1R w Englehard CST-1 Coating
798642+	07-17-79	33160	HWFE	N/R	.0000	1.6430	N/R	31.3385	Texaco A-1R w Englehard CST-1 Coating
798644	07-19-79	33299	FTP	N/R	.0349	1.6893	.253	27.2091	Texaco A-1R w Englehard CST-1 Coating
798649	07-20-79	33353	HWFE	N/R	.0000	1.4440	1.200	34.5386	Texaco A-1R w Englehard CST-1 Coating
798649+	07-20-79	33353	HWFE	N/R	.0000	1.4850	.950	33.2896	Texaco A-1R w Englehard CST-1 Coating
MEAN (COUNT):			FTP	.03207(8)	.0340(9)	1.8420(9)	.285(9)	25.1367(9)	
STANDARD DEVIATION:				.01307	.0146	.0734	.032	.8501	
MEAN (COUNT):			HWFE	.01091(3)	.0001(13)	1.6531(9)	.894(12)	32.5299(13)	
STANDARD DEVIATION:				.00209	.0003	.1342	.323	2.9065	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 6-12-79 THROUGH 8- 1-79):
*
* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:
*
* FTP .1155 .0379 .9811 .5892 1.0099
*
* HWFE .1055 .0002 .9548 2.6359 1.0708
*

* TRAP EFFICIENCY:

		FTP	88.4%	96.2%	1.9%	41.1%	0.1%
		HWFE	89.4%	99.98%	4.5%	-163.6%	7.1%

798933	08-01-79	33524	FTP	.26343	.8837	1.7439	.577	26.5641	Dummy Trap
798934	08-01-79	33544	HWFE	.10893	.5289	1.5575	.360	32.1971	Dummy Trap
MEAN (COUNT):			FTP (1)	.26343	.8837	1.7439	.577	26.5641	
MEAN (COUNT):			HWFE(1)	.10893	.5289	1.5575	.360	32.1971	

798936	08-02-79	33587	FTP	.31260	.8546	1.7350	.288	26.6955	ICI Saffil
798937	08-02-79	33608	HWFE	.09020	.4993	1.5193	.280	33.2603	ICI Saffil
798939	08-03-79	33636	FTP	.24856	.7915	1.7506	.351	26.5080	ICI Saffil
798940	08-03-79	33656	HWFE	N/R	.4910	1.6070	.197	31.9645	ICI Saffil
798941	08-09-79	33987	HWFE	N/R	.5310	1.6860	.238	31.0015	ICI Saffil
798942	08-10-79	34112	FTP	.21387	.8123	1.7135	.303	27.0058	ICI Saffil
798946	08-16-79	34281	FTP	N/R	.7603	1.9395	.606	23.9788	ICI Saffil
798947	08-16-79	34302	HWFE	N/R	.5330	1.7810	.615	28.8167	ICI Saffil
none			STEADY STATE						REGENERATION
798948	08-22-79	34410	FTP	N/R	.8303	1.8350	.350	24.6696	ICI Saffil
798949	08-22-79	34430	HWFE	N/R	.5520	1.6900	.202	30.1568	ICI Saffil
798950	08-24-79	34464	FTP	.22490	.9047	1.8405	.406	24.1727	ICI Saffil
798951	08-24-79	34484	HWFE	.07400	.5400	1.6750	.224	30.1209	ICI Saffil
798952	08-30-79	34762	FTP	.23868	.8294	1.9844	.477	23.3990	ICI Saffil
798953	08-30-79	34782	HWFE	.08700	.5270	1.7750	.313	29.3039	ICI Saffil
none			STEADY STATE						REGENERATION
798954	08-31-79	34877	HWFE	N/R	.5440	1.7870	.246	28.9156	ICI Saffil
798955	09-05-79	34910	FTP	N/R	.8983	2.0067	.296	23.6871	ICI Saffil
MEAN (COUNT):			FTP	.24772(5)	.8352(8)	1.8506(8)	.385(8)	25.0146(8)	
STANDARD DEVIATION:				.03860	.0497	.1151	.110	1.4781	
MEAN (COUNT):			HWFE	.08373(3)	.5272(8)	1.6900(8)	.289(8)	30.4425(8)	
STANDARD DEVIATION:				.00858	.0214	.0935	.137	1.5595	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 8- 1-79 THROUGH 10-16-79):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.9497	.9231	.9696	.7925	1.0365
HWFE	.8611	.9827	.9643	.8216	1.0299

* TRAP EFFICIENCY:

FTP	5.0%	7.7%	4.0%	20.7%	3.6%
HWFE	13.9%	1.7%	3.6%	17.8%	3.0%

798956	09-19-79	34941	FTP	.14236	.7621	1.8417	.078	25.4088	Corning EX-40
798957	09-19-79	34962	HWFE	.07383	.4401	1.6316	.074	31.7207	Corning EX-40
MEAN	(COUNT):		FTP (1)	.14236	.7621	1.8417	.078	25.4088	
MEAN	(COUNT):		HWFE(1)	.07383	.4401	1.6316	.074	31.7207	

Testing terminated due to high EGBP.

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 8- 1-79 THROUGH 10-16-79):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.5458	.8423	.9730	.1606	1.0529
HWFE	.7593	.8204	.9309	.2104	1.0731

* TRAP EFFICIENCY:

FTP	45.4%	15.8%	2.7%	83.9%	5.3%
HWFE	24.1%	18.0%	6.9%	79.0%	7.3%

798959	09-26-79	35004	FTP	.23029	.8881	2.0535	.049	22.7168	BALSTON FILTER
798960	09-26-79	35027	HWFE	.08500	.5180	1.8280	.210	28.3144	BALSTON FILTER
799469	10-04-79	35061	FTP	.24870	.8670	1.9498	.338	23.3941	BALSTON FILTER
799470	10-04-79	35085	HWFE	.09414	.5350	1.7667	.320	29.1574	BALSTON FILTER
MEAN	(COUNT):		FTP (2)	.23950	.8776	2.0016	.194	23.0554	
	STANDARD DEVIATION:			.01302	.0149	.0733	.204	.4789	
MEAN	(COUNT):		HWFE(2)	.08957	.5265	1.7974	.265	28.7359	
	STANDARD DEVIATION:			.00646	.0120	.0433	.078	.5961	

Testing terminated due to failure of one of the seven trapping elements.

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 8- 1-79 THROUGH 10-16-79):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.9182	.9699	1.0575	.3983	.9554
HWFE	.9212	.9814	1.0255	.7534	.9722

* TRAP EFFICIENCY:

FTP	8.2%	3.0%	-5.8%	60.2%	-4.5%
HWFE	7.9%	1.9%	-2.6%	24.7%	-2.8%

799471	10-11-79	35105	FTP	.30883	.9336	1.9554	.479	23.4320	Dummy Trap
799472	10-12-79	35131	FTP	.30135	.9090	1.9205	.460	23.8193	Dummy Trap
799473	10-12-79	35152	HWFE	.10300	.5320	1.8020	.356	29.1344	Dummy Trap
799474	10-15-79	35177	FTP	.21223	.8868	1.9333	.472	23.4526	Dummy Trap
799475	10-15-79	35188	HWFE	.09500	.5320	1.8220	.350	28.5961	Dummy Trap
799477	10-16-79	35252	FTP	.21836	.9104	1.9113	.442	23.3957	Dummy Trap
799478	10-16-79	35273	HWFE	.08200	.5530	1.8290	.340	28.3065	Dummy Trap
MEAN (COUNT):			FTP (4)	.26019	.9100	1.9301	.463	23.5249	
STANDARD DEVIATION:				.05199	.0191	.0191	.016	.1977	
MEAN (COUNT):			HWFE(3)	.09333	.5390	1.8177	.349	28.6790	
STANDARD DEVIATION:				.01060	.0121	.0140	.008	.4201	

799476	10-15-79	35227	STDY ST	.060	.430	1.943	.294	25.0	Baseline @ 8 MIN THROTTLED @60 MPH
799476+	10-15-79	35235	STDY ST	.070	.481	2.009	.358	29.0	Baseline @ 4 MIN UNTHROTTLED @60 MPH
799479	10-16-79	35307	STDY ST	N/R	.406	1.990	.249	24.7	Baseline @ 8 MIN THROTTLED @60 MPH
799479+	10-16-79	35316	STDY ST	N/R	.491	2.088	.363	28.1	Baseline @ 4 MIN UNTHROTTLED @60 MPH
799480	10-19-79	35433	STDY ST	.067	.689	1.783	.155	28.0	ICI Saffil @ 8 MIN THROTTLED @60 MPH
799480+	10-19-79	35441	STDY ST	.060	.690	1.768	.329	31.1	ICI Saffil @ 4 MIN UNTHROTTLED @60 MPH
NONE	10-23-79	35527	STDY ST	(SITE MALFUNCTION)					ICI Saffil REGENERATION ATTEMPTED
799483	10-25-79	35790	STDY ST	.051	1.302	1.897	.160	24.9	ICI Saffil @ 8 MIN THROTTLED @60 MPH
799483+	10-25-79	35798	STDY ST	.042	.827	2.055	.303	27.7	ICI Saffil @ 4 MIN UNTHROTTLED @60 MPH

Test sequence to determine relative emissions during the regeneration process.

799481	10-31-79	35826	FTP	.00782	.0096	1.9224	.249	24.0071	Texaco A-1R w Englehard CST-1 Coating #2
799482	10-31-79	35850	HWFE	.11000	.0020	1.8110	.853	28.7544	Texaco A-1R w Englehard CST-1 Coating #2
799484	11-01-79	35898	FTP	.02400	.0199	1.8960	.220	24.8227	Texaco A-1R w Englehard CST-1 Coating #2
799485	11-01-79	35920	HWFE	.05600	-.0040	1.7760	.896	29.7270	Texaco A-1R w Englehard CST-1 Coating #2
MEAN (COUNT):			FTP (2)	.01591	.0148	1.9092	.234	24.4149	
STANDARD DEVIATION:				.01144	.0073	.0187	.021	.5767	
MEAN (COUNT):			HWFE(2)	.08300	.0010	1.7935	.874	29.2407	
STANDARD DEVIATION:				.03818	.0014	.0247	.030	.6877	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 10-11-79 THROUGH 10-16-79):

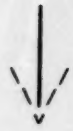
RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.0611	.0163	.9892	.5054	1.0378
HWFE	.8843	.0019	.9867	2.5043	1.0196

TRAP EFFICIENCY:

FTP	93.9%	98.4%	1.1%	49.5%	3.8%
HWFE	11.1%	99.8%	1.3%	-150.4%	2.0%

2,000 miles accumulated



799486	01-10-80	37954	FTP	1.37300*	.1668	1.8195	.517*	25.0364	Texaco A-1R w Englehard CST-1 Coating #2
799487	01-10-80	37974	HWFE	.30500	.0000	1.6520	.562	30.1726	Texaco A-1R w Englehard CST-1 Coating #2
799488	01-15-80	38030	FTP	.18833	.2162	1.8188	.372	22.1924	Texaco A-1R w Englehard CST-1 Coating #2
799490	01-15-80	38042	HWFE	.00100	.0000	1.7030	.888	30.6885	Texaco A-1R w Englehard CST-1 Coating #2
MEAN (COUNT):			FTP (2)	.78066	.1915	1.8192	.444	23.6144	
STANDARD DEVIATION:				.83769	.0349	.0005	.103	2.0110	
MEAN (COUNT):			HWFE(2)	.15300	.0000	1.6775	.725	30.4306	
STANDARD DEVIATION:				.21496	.0000	.0361	.231	.3648	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 1-17-80 THROUGH 1-18-80):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	2.3289	.2058	1.0117	.9569	.9199
HWFE	1.5455	.0000	1.0081	2.0139	.9647

TRAP EFFICIENCY:

FTP	-132.9%	79.4%	-1.2%	4.3%	-8.0%
HWFE	-54.6%	100.0%	-0.8%	-101.4%	-3.5%

799491	01-17-80	38087	FTP	N/R	.9103	1.7673	.480	26.1133	Dummy Trap
799492	01-17-80	38108	HWFE	N/R	.5930	1.6890	.379	31.1792	Dummy Trap
799493	01-18-80	38132	FTP	.33521	.9510	1.8290	.447	25.2256	Dummy Trap
799494	01-18-80	38153	HWFE	.09900	.5140	1.6390	.342	31.9093	Dummy Trap
MEAN (COUNT):			FTP	.33521(1)	.9306(2)	1.7982(2)	.464(2)	25.6694(2)	
STANDARD DEVIATION:				N/A	.0288	.0436	.023	.6277	
MEAN (COUNT):			HWFE	.09900(1)	.5535(2)	1.6640(2)	.360(2)	31.5442(2)	
STANDARD DEVIATION:				N/A	.0559	.0354	.026	.5163	

799495	01-29-80	38205	FTP	.26665	.9014	1.9643	.121	24.2807	Corning EX-47 6" non-catalyzed
799496	01-29-80	38218	HWFE	.07100	.5140	1.8300	.131	29.0773	Corning EX-47 6" non-catalyzed
799497	01-30-80	38265	FTP	.22274	.9142	2.0427	.172	23.8886	Corning EX-47 6" non-catalyzed
MEAN (COUNT):			FTP (2)	.24470	.9078	2.0035	.146	24.0846	
STANDARD DEVIATION:				.03105	.0091	.0554	.036	.2773	
MEAN (COUNT):			HWFE(1)	.07100	.5140	1.8300	.131	29.0773	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 1-17-80 THROUGH 1-18-80):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.7300	.9755	1.1142	.3147	.9383
HWFE	.7172	.9286	1.0998	.3639	.9218

* TRAP EFFICIENCY:

FTP	27.0%	2.4%	-11.4%	68.5%	-6.2%
HWFE	28.3%	7.1%	-10.0%	63.6%	-7.8%

801739	01-31-80	38289	FTP	.15769	.4735	1.8834	.109	25.7561	Corning EX-47 6" w Englehard CST-1 Coating
801463	01-31-80	38298	HWFE	.05000	.0350	1.8410	.312	29.0483	Corning EX-47 6" w Englehard CST-1 Coating
798961	02-01-80	38349	FTP	.08895	.2510	1.8403	.128	24.8488	Corning EX-47 6" w Englehard CST-1 Coating
799468	02-01-80	38360	HWFE	.00200	.0200	1.6820	.497	31.0822	Corning EX-47 6" w Englehard CST-1 Coating
none	02-01-80		STEADY STATE						REGENERATION ATTEMPTED
MEAN (COUNT):			FTP (2)	.12332	.3622	1.8618	.118	25.3024	
STANDARD DEVIATION:				.04861	.1573	.0305	.013	.6416	
MEAN (COUNT):			HWFE(2)	.02600	.0275	1.7615	.404	30.0652	
STANDARD DEVIATION:				.03394	.0106	.1124	.131	1.4382	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 1-17-80 THROUGH 1-18-80):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.3679	.3892	1.0354	.2543	.9857
HWFE	.2626	.0497	1.0586	1.1222	.9531

* TRAP EFFICIENCY:

FTP	63.2%	61.1%	-3.5%	74.6%	-1.4%
HWFE	73.7%	95.0%	-5.9%	-12.2%	-4.7%

801464	02-12-80	38429	FTP	.28587	.9080	1.7322	.110	26.9074	Corning EX-47 12" non-catalyzed
801465	02-12-80	38440	HWFE	.09100	.5220	1.6090	.091	31.9833	Corning EX-47 12" non-catalyzed
801466	02-14-80	38491	FTP	N/R	.9112	1.7259	.114	26.8053	Corning EX-47 12" non-catalyzed
801467	02-14-80	38504	HWFE	N/R	.5340	1.6710	.184	31.5125	Corning EX-47 12" non-catalyzed
801468	02-15-80	38543	FTP	N/R	.9103	1.7941	.105	25.7925	Corning EX-47 12" non-catalyzed
801469	02-15-80	38566	HWFE	N/R	.5110	1.7070	.095	30.6842	Corning EX-47 12" non-catalyzed
801470	02-22-80	38622	FTP	N/R	.8644	1.7095	.129	26.8103	Corning EX-47 12" non-catalyzed
801471	02-22-80	38633	HWFE	N/R	N/R	N/R	.096	N/R	Corning EX-47 12" non-catalyzed
none			STEADY STATE						REGENERATION
801472	02-27-80	38735	FTP	N/R	.8971	1.7094	.086	27.1632	Corning EX-47 12" non-catalyzed
801473	02-27-80	38755	HWFE	N/R	N/R	N/R	.077	N/R	Corning EX-47 12" non-catalyzed
801474	02-28-80	38787	FTP	N/R	.8794	1.7698	.107	25.9227	Corning EX-47 12" non-catalyzed
801730	02-28-80	38807	HWFE	N/R	.5120	1.7750	.092	29.8238	Corning EX-47 12" non-catalyzed
801731	02-29-80	38837	FTP	N/R	.8774	1.8183	.113	25.3441	Corning EX-47 12" non-catalyzed
801732	02-29-80	38851	HWFE	N/R	.5210	1.8240	.097	28.6993	Corning EX-47 12" non-catalyzed
none			STEADY STATE						REGENERATION
801733	03-12-80	38917	FTP	N/R	.9994	1.8801	.102	24.3600	Corning EX-47 12" non-catalyzed
801737	03-13-80	38985	FTP	N/R	.9856	1.8533	.108	24.2421	Corning EX-47 12" non-catalyzed
801979	03-27-80	39246	FTP	.17424	.9376	1.9852	.274	22.6712	Corning EX-47 12" non-catalyzed
801987	04-02-80	39310	FTP	N/R	.9359	1.8778	.465	23.0961	Corning EX-47 12" non-catalyzed
802070	04-08-80	39363	STEADY STATE						REGENERATION
802071	04-09-80	39420	FTP	N/R	.9510	1.6770	.178	25.8463	Corning EX-47 12" non-catalyzed
802072	04-10-80	39433	FTP	N/R	.9695	1.8003	.233	24.6623	Corning EX-47 12" non-catalyzed
802074	04-11-80	39465	HWFE	N/R	.5665	1.7174	.205	29.0841	Corning EX-47 12" non-catalyzed
802081	04-15-80	39517	HWFE	N/R	.5196	1.4680	.116	33.6024	Corning EX-47 12" non-catalyzed
802079	04-16-80	39567	HWFE	N/R	.5689	1.6203	.127	30.8460	Corning EX-47 12" non-catalyzed
MEAN (COUNT):			FTP	.23006(2)	.9251(13)	1.7948(13)	.163(13)	25.3557(13)	
STANDARD DEVIATION:				.07893	.0426	.0876	.107	1.4626	
MEAN (COUNT):			HWFE	.09100(1)	.5319(8)	1.6740(8)	.118(10)	30.7794(8)	
STANDARD DEVIATION:				N/A	.0232	.1103	.043	1.6073	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 1-17-80 THROUGH 10- 2-80):
*
* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:
*

FTP	.8640	1.0376	.9538	.3581	1.0406
HWFE	.9866	1.2502	1.0076	.3615	.9896

* TRAP EFFICIENCY:
*

FTP	13.6%	-3.8%	4.6%	64.1%	4.1%
HWFE	1.3%	-25.0%	-0.8%	63.8%	-1.0%

802089	09-24-80	39746	FTP	.25559	.9096	2.0111	.466	22.7109	Dummy Trap
802090	09-24-80	39759	HWFE	.08606	.4704	1.6364	.297	30.4779	Dummy Trap
802093	09-25-80	39796	FTP	.22429	.7732	1.9025	.440	23.9571	Dummy Trap
802094	09-25-80	39811	HWFE	.08864	.0462	1.6855	.305	30.5381	Dummy Trap
802097	10-02-80	39865	FTP	.25003	.9140	1.8984	.437	23.8279	Dummy Trap
806296	10-02-80	39878	HWFE	.09525	.5036	1.6569	.310	31.4106	Dummy Trap
MEAN (COUNT):			FTP (3)	.24330	.8656	1.9373	.448	23.4986	
STANDARD DEVIATION:				.01670	.0801	.0639	.016	.6852	
MEAN (COUNT):			HWFE(3)	.08998	.3401	1.6596	.304	30.8089	
STANDARD DEVIATION:				.00474	.2550	.0247	.007	.5220	
806543	10-23-80	39977	HWFE	.08398	.5677	1.7954	.172	28.6632	ICI Saffil fourth generation
806548	10-28-80	40036	HWFE	.07364	.5411	1.7617	.204	30.7475	ICI Saffil fourth generation
806553	02-26-81	40664	HWFE	.06511	.6033	1.8042	.327	29.5797	ICI Saffil fourth generation
806552	03-04-81	40694	HWFE	.16804	.6341	2.0497	.335	27.4002	ICI Saffil fourth generation
807882	03-06-81	40746	FTP	.24406	1.0734	2.0956	.545	21.6846	ICI Saffil fourth generation
807883	03-06-81	40767	HWFE	.08749	.5623	1.9021	.336	27.7262	ICI Saffil fourth generation
807886	03-10-81	40811	FTP	.32480	1.1537	2.0441	1.419*	21.7132	ICI Saffil fourth generation
807889	04-02-81	41126	FTP	.32198	1.0848	2.0639	.533	22.3383	ICI Saffil fourth generation
807890	04-02-81	41136	HWFE	.11203	.6043	1.8766	.339	28.2538	ICI Saffil fourth generation
807892	04-08-81	41333	FTP	.31474	1.0813	2.1354	.569	22.0491	ICI Saffil fourth generation
807893	04-08-81	41344	HWFE	.10152	.5807	1.8996	.366	28.0258	ICI Saffil fourth generation
807894	04-08-81	41375	HWFE	.08552	.5960	1.9040	.327	27.8745	ICI Saffil fourth generation
MEAN (COUNT):			FTP (4)	.30140	1.0983	2.0848	.766	21.9463	
STANDARD DEVIATION:				.03846	.0372	.0399	.435	.3093	
MEAN (COUNT):			HWFE(8)	.09717	.5862	1.8742	.301	28.5339	
STANDARD DEVIATION:				.03218	.0292	.0901	.071	1.1161	

*Testing terminated due to insufficient trapping efficiency.

EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 9-24-80 THROUGH 4-16-81):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	1.1395	1.1602	1.0480	1.4938	.9559
HWFE	1.0217	1.3261	1.0714	.8980	.9593

TRAP EFFICIENCY:

FTP	-14.0%	-16.0%	-4.8%	-49.4%	-4.4%
HWFE	-2.2%	-32.6%	-7.1%	10.2%	-4.1%

807898	04-15-81	41455	FTP	.31280	1.0573	2.0670	.648	21.9558	Dummy Trap
807899	04-15-81	41475	HWFE	.10621	.5960	1.8977	.388	28.2563	Dummy Trap
808687	04-16-81	41494	FTP	.27976	1.0791	2.0674	.571	22.3448	Dummy Trap
808688	04-16-81	41504	HWFE	.09940	.5941	1.8702	.377	28.1022	Dummy Trap
MEAN (COUNT):			FTP (2)	.29628	1.0682	2.0672	.610	22.1503	
STANDARD DEVIATION:				.02336	.0154	.0003	.054	.2751	
MEAN (COUNT):			HWFE(2)	.10280	.5950	1.8840	.382	28.1792	
STANDARD DEVIATION:				.00482	.0013	.0194	.008	.1090	
808690	04-17-81	41544	FTP	.11478	.1102	2.0743	.278	22.1526	Corning EX-47 12" w UOP Coating
808691	04-17-81	41552	HWFE	.01287	.0000	1.8433	1.071	28.3532	Corning EX-47 12" w UOP Coating
808740	04-21-81	41606	HWFE	.03256	.0000	1.8616	1.160	27.8063	Corning EX-47 12" w UOP Coating
808739	04-22-81	41625	FTP	.08400	.1153	2.0505	.352	22.4502	Corning EX-47 12" w UOP Coating
MEAN (COUNT):			FTP (2)	.09939	.1127	2.0624	.315	22.3014	
STANDARD DEVIATION:				.02176	.0036	.0168	.052	.2104	
MEAN (COUNT):			HWFE(2)	.02272	.0000	1.8524	1.116	28.0798	
STANDARD DEVIATION:				.01392	.0000	.0129	.063	.3867	Testing suspended due to question of whether vehicle is stable.

EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 4-15-81 THROUGH 8- 6-81):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.3824	.1150	1.0010	.5912	.9877
HWFE	.2062	.0000	1.0377	2.9715	.9887

TRAP EFFICIENCY:

FTP	61.8%	88.5%	-0.1%	40.9%	-1.2%
HWFE	79.4%	100.0%	-3.8%	-197.1%	-1.1%

808744	04-28-81	41687	FTP	.28905	.9238	2.1493	.492	22.5037	Dummy Trap
808745	04-28-81	41701	HWFE	.11968	.5436	1.7758	.391	28.4965	Dummy Trap
808747	04-29-81	41728	FTP	.29025	.8899	2.0740	.491	22.4566	Dummy Trap
808748	04-29-81	41738	HWFE	.11401	.5233	1.7676	.358	28.3420	Dummy Trap
808750	05-05-81	41787	FTP	.29302	.9507	2.0585	.527	22.7017	Dummy Trap
808751	05-05-81	41807	HWFE	.11826	.5695	1.7760	.357	28.1005	Dummy Trap
809067	07-29-81	41834	FTP	.05667*	.9867	2.1268	N/R	22.2888	Dummy Trap
809068	07-29-81	41855	HWFE	.11059	.5610	1.8147	N/R	27.9490	Dummy Trap
809071	08-05-81	41911	FTP	.27450	.9714	1.9552	.489	23.1682	Dummy Trap
809072	08-05-81	41932	HWFE	.10274	.5844	1.6642	.372	29.0654	Dummy Trap
809075	08-06-81	41960	FTP	.28308	.9826	1.9848	.511	23.2185	Dummy Trap
809076	08-06-81	41981	HWFE	.11055	.5812	1.7147	.388	28.8986	Dummy Trap
MEAN (COUNT):			FTP	.24776(6)	.9508(6)	2.0581(6)	.502(5)	22.7229(6)	
STANDARD DEVIATION:				.09385	.0378	.0765	.016	.3878	
MEAN (COUNT):			HWFE	.11264(6)	.5605(6)	1.7522(6)	.373(5)	28.4753(6)	
STANDARD DEVIATION:				.00616	.0235	.0537	.016	.4389	

810401	09-01-81	42036	FTP	.11023	.3076	2.0138	.245	23.3040	Corning EX-47 12" w UOP Coating
810402	09-01-81	42065	HWFE	.02442	.0507	1.8300	.453	29.4085	Corning EX-47 12" w UOP Coating
810404	09-03-81	42104	FTP	.14042	.2757	1.9635	.332	22.3305	Corning EX-47 12" w UOP Coating
810405	09-03-81	42116	HWFE	.01907	.0361	1.6911	.566	28.1124	Corning EX-47 12" w UOP Coating
810407	09-09-81	42159	FTP	.10008	.2434	1.9717	.259	23.3112	Corning EX-47 12" w UOP Coating
810779	09-15-81	42205	HWFE	.00762	.0218	1.7136	.436	28.6712	Corning EX-47 12" w UOP Coating
810784	09-24-81	42327	FTP	.03000	.1864	1.9685	.197	22.7543	Corning EX-47 12" w UOP Coating
810785	09-24-81	42342	HWFE	.00556	.0147	1.7196	.631	28.3533	Corning EX-47 12" w UOP Coating
810790	09-30-81	42381	FTP	.07481	.1948	2.0132	.274	22.4454	Corning EX-47 12" w UOP Coating
810791	10-01-81	42396	HWFE	.01446	.0215	1.7616	.631	27.9608	Corning EX-47 12" w UOP Coating
810787	10-09-81	42458	STEADY STATE						REGENERATION
810788	10-15-81	42465	FTP	.09844	.3476	1.9016	.282	23.2494	Corning EX-47 12" w UOP Coating
810789	10-15-81	42481	HWFE	.01617	.1017	1.7686	.633	28.4189	Corning EX-47 12" w UOP Coating
811167	10-20-81	42532	FTP	.06770	.2073	2.0266	.249	22.3962	Corning EX-47 12" w UOP Coating
811168	10-20-81	42542	HWFE	.01197	.0145	1.8364	.804	27.8095	Corning EX-47 12" w UOP Coating
811170	10-21-81	42619	STEADY STATE						REGENERATION
811271	10-27-81	42708	HWFE	.02329	.0291	1.6961	.645	28.5858	Corning EX-47 12" w UOP Coating
811273	10-29-81	42802	FTP	.10971	.3579	1.9589	.493	23.4070	Corning EX-47 12" w UOP Coating
MEAN (COUNT):			FTP (8)	.09142	.2651	1.9772	.291	22.8998	
STANDARD DEVIATION:				.03343	.0679	.0404	.090	.4656	
MEAN (COUNT):			HWFE(8)	.01532	.0363	1.7521	.600	28.4150	
STANDARD DEVIATION:				.00684	.0290	.0572	.117	.5000	

Testing terminated due to radial crack 2/3 way down trap.

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 4-28-81 THROUGH 11-17-81):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.3642	.2822	.9702	.5948	1.0006
HWFE	.1436	.0657	.9978	1.6655	.9950

TRAP EFFICIENCY:

FTP	63.6%	72.8%	3.0%	40.5%	0.06%
HWFE	85.6%	93.4%	0.2%	-66.6%	-0.5%

811274	11-10-81	42839	FTP	.24975	.9307	1.9580	.502	23.3885	Dummy Trap
811275	11-10-81	42849	HWFE	.09128	.5311	1.7109	.346	28.7469	Dummy Trap
811277	11-12-81	42888	FTP	.25987	.8883	2.0316	.448	22.9682	Dummy Trap
811278	11-12-81	42899	HWFE	.09170	.5327	1.8162	.341	28.5051	Dummy Trap
811280	11-17-81	42937	FTP	.26283	.9303	2.0039	.455	23.2794	Dummy Trap
811281	11-17-81	42948	HWFE	.10115	.5492	1.7630	.329	28.9054	Dummy Trap
MEAN (COUNT):			FTP (3)	.25748	.9164	1.9978	.468	23.2120	
STANDARD DEVIATION:				.00686	.0244	.0372	.029	.2181	
MEAN (COUNT):			HWFE(3)	.09471	.5377	1.7634	.339	28.7191	
STANDARD DEVIATION:				.00558	.0100	.0527	.009	.2016	

811617	11-25-81	42989	FTP	.22543	.9172	2.0467	.065	23.5563	NGK #2
811618	11-25-81	43004	HWFE	.07731	.5150	1.8273	.055	28.9159	NGK #2
811620	12-01-81	43045	FTP	.21110	.8418	1.8357	.069	24.8297	NGK #2
811621	12-01-81	43059	HWFE	.05556	.4925	1.7006	.051	29.0897	NGK #2
811623	12-02-81	43091	FTP	.17174	.9006	1.9080	.076	24.8923	NGK #2
811624	12-02-81	43107	HWFE	.04629	.4547	1.6543	.053	31.9260	NGK #2
811626	12-09-81	43202	FTP	.14880	.8705	2.0084	.062	22.1381	NGK #2
811762	12-09-81	43215	HWFE	.04778	.4684	1.8342	.061	27.7469	NGK #2
811764	12-09-81	43264	STEADY STATE						REGENERATION
811765	12-10-81	43281	FTP	.12539	.8514	2.0077	.049	22.9416	NGK #2
811766	12-10-81	43294	HWFE	.03666	.4561	1.7915	.034	28.2124	NGK #2
811768	12-11-81	43335	FTP	.09947	.8498	1.9680	.055	22.9977	NGK #2
811815	12-11-81	43338	HWFE	.03259	.4402	1.7176	.036	28.8552	NGK #2
811816	12-16-81	43374	STEADY STATE						REGENERATION
811817	12-17-81	43397	FTP	.10905	.8667	1.9643	.058	23.0468	NGK #2
811818	12-17-81	43410	HWFE	.03871	.4445	1.7493	.024	28.9350	NGK #2
811820	12-22-81	43494	FTP	.18491	.9166	2.0677	.065	22.0332	NGK #2
811821	12-22-81	43507	HWFE	.04120	.4349	1.8752	.037	27.3792	NGK #2
811823	12-23-81	43547	STEADY STATE						REGENERATION ATTEMPTED
811824	01-06-82	43590	STEADY STATE						REGENERATION
none	01-20-82	43819	STEADY STATE						REGENERATION
MEAN (COUNT):			FTP (8)	.15949	.8768	1.9758	.062	23.3045	
STANDARD DEVIATION:				.04665	.0305	.0756	.008	1.0810	
MEAN (COUNT):			HWFE(8)	.04701	.4633	1.7688	.044	28.8825	
STANDARD DEVIATION:				.01419	.0277	.0759	.013	1.3789	

EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 11-10-81 THROUGH 11-17-81):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.6194	.9568	.9890	.1325	1.0040
HWFE	.4964	.8616	1.0031	.1298	1.0057

TRAP EFFICIENCY:

FTP	38.1%	4.3%	1.1%	86.8%	-0.4%
HWFE	50.4%	13.8%	-0.3%	87.0%	-0.6%

Appendix A-2

Test Data on Peugeot 504 Diesel

VEHICLE I.D. 504ACO-2700783 (1978 PEUGEOT 504)

TEST NUMBER	TEST DATE	ODOM (MI)	TEST CYCLE	EMMISIONS (G/MI) HC	CO	NOx	TP	F.E. (mpg)	TRAP TYPE
799861	09-12-79	7375	FTP	.68810	1.5910	1.1912	.369	26.1117	Baseline
799862	09-12-79	7397	HWFE	.28700	.6260	1.0380	.233	33.2192	Baseline
799867	10-26-79	7501	FTP	.62320	1.3980	1.1561	.309	24.6886	Baseline
799868	10-26-79	7521	HWFE	.23670	.5860	1.0260	.202	33.8399	Baseline
799869	10-30-79	7541	FTP	.93810	1.5680	1.1371	N/R	26.9561	Baseline
799870	10-31-79	7552	FTP	.78200	1.5280	1.0046	.254	32.4244	Baseline
799871	10-31-79	7572	HWFE	.28170	.6770	.7004	.209	33.4744	Baseline
799872	11-01-79	7586	FTP	.82170	1.7160	1.1748	.318	27.9346	Baseline
799873	11-01-79	7606	HWFE	.28600	.6590	1.1120	.210	33.9642	Baseline
MEAN (COUNT):			FTP	.77062(5)	1.5602(5)	1.1328(5)	.312(4)	27.6231(5)	
STANDARD DEVIATION:				.12179	.1147	.0744	.047	2.9364	
MEAN (COUNT):			HWFE(4)	.27285	.6370	.9691	.214	33.6244	
STANDARD DEVIATION:				.02421	.0400	.1831	.013	.3409	
800500	11-20-79	7854	FTP	.07990	.0650	1.0354	.095	26.6096	Johnson-Matthey JM-4 #1
800501	11-20-79	7874	HWFE	N/R	.0000	.9663	.265	33.9158	Johnson-Matthey JM-4 #1
800503	11-21-79	7917	FTP	N/R	.1080	N/R	.153	26.0020	Johnson-Matthey JM-4 #1
800504	11-21-79	7928	HWFE	N/R	-.0040	N/R	.943	32.8218	Johnson-Matthey JM-4 #1
800506	11-28-79	7987	FTP	N/R	.0960	1.1138	.096	26.1377	Johnson-Matthey JM-4 #1
800507	11-28-79	7998	HWFE	N/R	.0000	.9775	.703	34.3741	Johnson-Matthey JM-4 #1
800512	12-11-79	8500	FTP	.08960	.0660	1.0794	.654	25.7327	Johnson-Matthey JM-4 #1
800513	12-11-79	8522	HWFE	N/R	.0000	.9800	1.281	32.5947	Johnson-Matthey JM-4 #1
800514	12-12-79	8559	FTP	.03260	.0680	1.1145	.541	25.9420	Johnson-Matthey JM-4 #1
800515	12-12-79	8570	HWFE	.06600	.0000	.9360	1.144	33.3404	Johnson-Matthey JM-4 #1
MEAN (COUNT):			FTP	.06737(3)	.0806(5)	1.0858(4)	.308(5)	26.0848(5)	
STANDARD DEVIATION:				.03050	.0200	.0374	.268	.3277	
MEAN (COUNT):			HWFE	.06600(1)	.0000(5)	.9650(4)	.867(5)	33.4094(5)	
STANDARD DEVIATION:				N/A	.0000	.0202	.401	.7418	

Testing terminated after 600 miles due to higher TP emissions (on FTP, LA-4, & HWFE) than baseline, also high EGBP.

EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA FROM BASELINE TESTING (9-12-79 THROUGH 3-13-79):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.0874	.0528	.9683	.9716	.9443
HWFE	.2419	.0000	.9822	4.0704	1.0024

TRAP EFFICIENCY:

FTP	91.3%	94.7%	3.2%	2.8%	-5.6%
HWFE	75.8%	100.0%	1.8%	-307.0%	0.2%

800517	02-29-80	8368	FTP	N/R	1.3410	1.0895	.336	27.9779	Baseline
800518	03-12-80	8378	FTP	N/R	1.5440	1.0967	.318	27.2677	Baseline
800530	03-13-80	8687	HWFE	N/R	.6880	1.0360	.209	32.1563	Baseline
MEAN (COUNT):			FTP (2)	N/A	1.4425	1.0931	.327	27.6228	
STANDARD DEVIATION:				N/A	.1435	.0051	.013	.5022	
MEAN (COUNT):			HWFE(1)	N/A	.6880	1.0360	.209	32.1563	
800531	03-27-80	8736	FTP	.02850	.0560	1.1099	.186	24.8644	Johnson-Matthey JM-4 #2
800532	03-27-80	8749	HWFE	N/R	.0120	.9790	.223	32.6494	Johnson-Matthey JM-4 #2
800533	03-28-80	8792	FTP	.05180	.1220	.9714	.140	29.7264	Johnson-Matthey JM-4 #2
800534	03-28-80	8806	HWFE	N/R	.0020	.8970	N/R	36.3474*	Johnson-Matthey JM-4 #2
800524	04-02-80	8879	FTP	N/R	.1750	1.0617	N/R	27.2441	Johnson-Matthey JM-4 #2
800525	04-02-80	8897	HWFE	N/R	.0120	.9300	.764	34.7736	Johnson-Matthey JM-4 #2
800526	04-09-80	8954	FTP	N/R	.1750	.9846	.274	27.3931	Johnson-Matthey JM-4 #2
800527	04-09-80	8979	HWFE	N/R	.0160	.9830	1.182	32.5472	Johnson-Matthey JM-4 #2
800528	04-10-80	9035	FTP	N/R	.1910	.9913	.290	27.6889	Johnson-Matthey JM-4 #2
800529	04-10-80	9059	HWFE	N/R	.0160	.9480	.992	32.3730	Johnson-Matthey JM-4 #2
800521	04-17-80	9246	HWFE	N/R	.0060	.8460	.816	35.5109	Johnson-Matthey JM-4 #2
800516	04-22-80	9315	FTP	N/R	.2010	.9568	.137	27.9936	Johnson-Matthey JM-4 #2
800535	05-22-80	9351	FTP	.16010	.1220	.9859	.178	28.3714	Johnson-Matthey JM-4 #2
800537	05-22-80	9374	HWFE	.09450	.0000	1.0140	1.095	33.8871	Johnson-Matthey JM-4 #2
MEAN (COUNT):			FTP	.08013(3)	.1489(7)	1.0088(7)	.201(6)	27.6177(7)	
STANDARD DEVIATION:				.07023	.0515	.0556	.066	1.4681	
MEAN (COUNT):			HWFE	.09450(1)	.0091(7)	.9424(7)	.845(6)	34.0127(7)	
STANDARD DEVIATION:				N/A	.0065	.0572	.344	1.5804	

Similar to JM-4 #1 but with superior flow characteristics.

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA FROM BASELINE TESTING (9-12-79 THROUGH 3-13-80):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.1040	.0975	.8995	.6413	.9996
HWFE	.3463	.0141	.9592	3.9671	1.0205

TRAP EFFICIENCY:

FTP	89.6%	90.2%	10.0%	35.9%	-0.04%
HWFE	65.4%	98.6%	4.1%	-296.7%	2.0%

1,000 miles accumulated

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* Questionable data

800519	06-03-80	10428	FTP	.62310	.4000	.9879	.457	22.7344	Johnson-Matthey JM-4 #2
800520	06-03-80	10443	HWFE	.13700	.0000	.8440	1.591	32.4518	Johnson-Matthey JM-4 #2
803659	06-04-80	10499	FTP	.29760	.2890	.9756	.436	26.6088	Johnson-Matthey JM-4 #2
803660	06-04-80	10519	HWFE	.05600	.0000	.8640	1.488	31.5449	Johnson-Matthey JM-4 #2
MEAN (COUNT):			FTP (2)	.46035	.3445	.9818	.446	24.6716	
STANDARD DEVIATION:				.23016	.0785	.0087	.015	2.7396	
MEAN (COUNT):			HWFE(2)	.09650	.0000	.8540	1.540	31.9984	
STANDARD DEVIATION:				.05728	.0000	.0141	.073	.6413	

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA FROM BASELINE TESTING (9-12-79 THROUGH 3-13-80):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.5974	.2257	.8755	1.4230	.8932
HWFE	.3537	.0000	.8692	7.2300	.9600

* TRAP EFFICIENCY:

FTP	40.3%	77.4%	12.5%	-42.3%	-10.7%
HWFE	64.6%	100.0%	13.1%	-623.0%	-4.0%

803628	07-03-80	10624	FTP	.02340	.0490	.7301	.144	27.1309	Johnson-Matthey JM-4 #2 w low sulfur fuel
803629	07-09-80	10654	FTP	.04950	.0530	.8671	.113	27.8548	Johnson-Matthey JM-4 #2 w low sulfur fuel
803630	07-09-80	10667	HWFE	N/R	-.0090	.7760	.286	33.9384	Johnson-Matthey JM-4 #2 w low sulfur fuel
803631	07-15-80	10717	HWFE	N/R	.0000	.7590	.259	33.4533	Johnson-Matthey JM-4 #2 w low sulfur fuel
803631+	07-15-80	10717	HWFE	N/R	.0000	.8030	N/R	32.3531	Johnson-Matthey JM-4 #2 w low sulfur fuel
MEAN (COUNT):			FTP (2)	.03645	.0510	.7986	.128	27.4928	
STANDARD DEVIATION:				.01846	.0028	.0969	.022	.5119	
MEAN (COUNT):			HWFE	N/A	.0000(3)	.7793(3)	.272(2)	32.2483(3)	
STANDARD DEVIATION:				N/A	.0000	.0222	.019	.8123	

* EFFECT OF LOW SULFUR FUEL ON ABOVE TRAP COMPARED TO SAME TRAP TESTED WITH NO. 2 DIESEL FUEL (3-22-80 THROUGH 6-4-80):

* RATIO OF TEST DATA WITH LOW SULFUR FUEL TO TEST DATA WITH NO. 2 DIESEL FUEL:

FTP	.1570	.2652	.7964	.4885	1.0198
HWFE	N/A	.0000	.8445	.2670	.9608

Appendix A-3

Test Data on Toyota Crown Diesel

VEHICLE I.D. K-LS110-SEMFSY (1981 TOYOTA CROWN SUPER-DELUX)

TEST NUMBER	TEST DATE	ODOM (KM)	TEST CYCLE	EMMISIONS (G/MI) HC	CO	NOx	TP	F.E. (mpg)	TRAP TYPE
810714	09-01-81	1730	FTP	.38349	1.1801	1.3974	.309	25.9541	Dummy Trap
810715	09-01-81	1737	HWFE	.18551	.5809	1.1950	.195	34.5527	Dummy Trap
810717	09-02-81	1812	HWFE	.18121	.5888	1.2716	.219	34.6704	Dummy Trap
810719	09-03-81	1864	FTP	.37204	1.1150	1.4581	.316	26.2304	Dummy Trap
810720	09-10-81	1903	FTP	.36574	1.1998	1.5903	.365	24.9378	Dummy Trap
810721	09-10-81	1943	HWFE	.18465	.5944	1.3013	.238	34.3181	Dummy Trap
810725	09-15-81	2080	FTP	.35640	1.1255	1.4865	.322	26.2327	Dummy Trap
810726	09-15-81	2090	HWFE	.17678	.5815	1.1317	.211	34.4391	Dummy Trap
MEAN (COUNT):			FTP (4)	.36942	1.1551	1.4831	.328	25.8388	
STANDARD DEVIATION:				.01137	.0413	.0806	.025	.6147	
MEAN (COUNT):			HWFE(4)	.18204	.5864	1.2249	.216	34.4951	
STANDARD DEVIATION:				.00397	.0064	.0766	.018	.1511	
810732	09-24-81	2360	FTP	.21746	1.0196	1.5550	.268	27.1144	ICI Saffil fourth generation
810935	10-01-81	2446	FTP	.33636	1.0705	1.4551	.237	25.9754	ICI Saffil fourth generation
810936	10-01-81	2456	HWFE	.14405	.5848	1.2018	.133	33.8778	ICI Saffil fourth generation
810938	10-06-81	2539	FTP	.33187	1.0511	1.5562	.215	26.6589	ICI Saffil fourth generation
810939	10-07-81	2564	FTP	.31036	.9942	1.5388	.184	26.4624	ICI Saffil fourth generation
810940	10-07-81	2623	HWFE	.15118	.5728	1.2244	.128	34.3343	ICI Saffil fourth generation
810942	10-08-81	2653	FTP	.31753	1.0445	1.5161	.213	26.1157	ICI Saffil fourth generation
810943	10-08-81	2678	HWFE	.15006	.5615	1.2100	.112	34.5698	ICI Saffil fourth generation
MEAN (COUNT):			FTP (5)	.30272	1.0360	1.5242	.223	26.4654	
STANDARD DEVIATION:				.04881	.0296	.0419	.031	.4531	
MEAN (COUNT):			HWFE(3)	.14843	.5730	1.2121	.124	34.2606	
STANDARD DEVIATION:				.00383	.0117	.0114	.011	.3518	

Testing terminated due to insufficient trapping efficiency.

* EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 9- 1-81 THROUGH 10-21-81):

* RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.8259	.9175	1.0209	.7217	1.0172
HWFE	.7810	.9659	1.0021	.5799	.9955

* TRAP EFFICIENCY:

FTP	17.4%	8.2%	-2.1%	27.8%	1.7%
HWFE	21.9%	3.4%	-0.2%	42.1%	-0.4%

810945	10-20-81	2755	FTP	.35207	1.0536	1.5053	.281	26.3099	Dummy Trap
810946	10-21-81	2777	FTP	.36940	1.1007	1.5201	.260	26.4376	Dummy Trap
811153	10-21-81	2796	HWFE	.20612	.6076	1.2002	.233	33.9633	Dummy Trap
811154	10-21-81	2830	HWFE	.20607	.6060	1.1572	.186	34.5397	Dummy Trap
MEAN (COUNT):			FTP (2)	.36074	1.0772	1.5127	.270	26.3738	
STANDARD DEVIATION:				.01225	.0333	.0105	.015	.0903	
MEAN (COUNT):			HWFE(2)	.20610	.6068	1.1787	.210	34.2515	
STANDARD DEVIATION:				.00004	.0011	.0304	.033	.4076	
811157	10-22-81	2925	FTP	.38914	1.0830	1.5009	.261*	26.3669	NGK #1
811158	10-27-81	2961	FTP	.34599	1.0565	1.4432	.133	27.1526	NGK #1
811159	10-27-81	2983	HWFE	.16529	.5658	1.1203	.086	35.1594	NGK #1
811161	10-28-81	3069	HWFE	.15884	.5687	1.1407	.046	34.2159	NGK #1
811378	11-10-81	3527	FTP	.27745	1.0549	1.4741	.063	26.2582	NGK #1
811379	11-10-81	3553	HWFE	.14245	.6550	1.1587	.039	33.4195	NGK #1
811380	11-12-81	3602	FTP	.23063	1.0664	1.4767	.048	26.1983	NGK #1
811381	11-12-81	3632	HWFE	.12921	.6301	1.1743	.032	33.3197	NGK #1
811576	11-18-81	4053	STEADY STATE						REGENERATION
811577	11-19-81	4073	FTP	.32747	1.1277	1.3938	.099	26.7916	NGK #1
811578	11-19-81	4098	HWFE	.17030	.5838	1.1158	.045	34.4417	NGK #1
811642	11-25-81	4171	FTP	.28351	.9312	1.5439	.101	26.3375	NGK #1
811643	11-25-81	4195	HWFE	.15453	.5837	1.2189	.049	33.5389	NGK #1
811645	12-08-81	4607	FTP	.35107	1.2275	1.5108	.068	25.2472	NGK #1
811646	12-08-81	4631	HWFE	.13262	.6370	1.2412	.039	32.9925	NGK #1
811648	12-10-81	4686	FTP	.23480	1.0190	1.5403	.049	25.3540	NGK #1
811649	12-10-81	4708	HWFE	.13451	.6937	1.2504	.029	32.2517	NGK #1
811788	12-11-81	4763	STEADY STATE						REGENERATION
811789	12-15-81	4805	FTP	.34349	.9934	1.4339	.154	27.1613	NGK #1
811790	12-15-81	4827	HWFE	.18716	.5992	1.1533	.061	35.3897	NGK #1
811792	12-16-81	4880	FTP	.40704	1.0452	1.4860	.102	26.9243	NGK #1
811793	12-16-81	4901	HWFE	.19454	.6579	1.2181	.059	34.1865	NGK #1
811797	01-07-82	5458	FTP	.24459	1.0765	1.4082	N/R	25.9273	NGK #1
812030	01-07-82	5481	HWFE	.14436	.6738	1.1214	N/R	34.0887	NGK #1
811985	01-08-82	5572	FTP	.27943	1.0366	1.4207	.066	26.2588	NGK #1
811986	01-08-82	5595	STEADY STATE						REGENERATION
811987	01-12-82	5639	FTP	.30177	1.0773	1.4173	.138	26.6623	NGK #1
811988	01-12-82	5660	HWFE	.17566	.6343	1.1255	.059	34.6649	NGK #1
811990	01-13-82	5725	FTP	.36439	1.1726	1.3707	.081	26.1593	NGK #1
811991	01-13-82	5749	HWFE	.20334	.6206	1.1007	.056	34.0763	NGK #1
MEAN (COUNT):			FTP (14)	.31291	1.0691	1.4638	.105	26.3428	
STANDARD DEVIATION:				.05679	.0728	.0525	.058	.5809	
MEAN (COUNT):			HWFE	.16099(13)	.6234(13)	1.1646(12)	.050(13)	33.9804(13)	
STANDARD DEVIATION:				.02434	.0409	.0514	.016	.8702	

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* Questionable data

EFFECTIVENESS OF ABOVE TRAP RELATIVE TO TEST DATA WITH DUMMY TRAP (FROM 10-20-81 THROUGH 10-21-81):

RATIO OF TEST DATA WITH TRAP TO TEST DATA WITH DUMMY TRAP:

FTP	.8674	.9925	.9677	.3889	.9988
HWFE	.7811	1.0274	.9880	.2381	.9921

TRAP EFFICIENCY:

FTP	13.3%	0.8%	3.2%	61.1%	-0.1%
HWFE	21.9%	-2.7%	1.2%	76.2%	-0.8%

Appendix B

Particulate Data on Certification Tests Conducted at EPA

APPENDIX B-1

DATA ON ALL DIESEL CAR FTP TESTS CONDUCTED BY EPA'S CERTIFICATION DIVISION THROUGH DECEMBER 31, 1981

MFR	VEHICLE I.D. NUMBER	TEST NUMBER	TEST TYPE	ODOM	EMISSIONS (G/MI) HC	CO	NOx	TP	MPG	ETW	CID	ENG. CONF	TRAN	EGR ?	TRBO ?	MODEL YEAR
AUDI	577-611	810699	EMIS	3918	.210	.67	1.16	.149	33.1	2750	97	L-4	A3	NO	YES	82
AUDI	577-614	810701	EMIS	3943	.177	.70	1.21	.142	36.4	2750	97	L-4	M5	NO	YES	82
AUDI	577-616	810128	EMIS	3949	.323	1.19	1.33	.336	37.0	2625	97	L-4	M5	NO	NO	82
AUDI	577-616	810191	FE	3993	.201	.68	1.14	.203	40.8	2625	97	L-4	M5	NO	NO	82
AUDI	503-637	807069	EMIS	3897	.296	.53	1.29	.379	26.8	3250	121	L-5	M5	NO	NO	81
GM	C1T059	807206	EMIS	4123	.172	.54	1.06	.163	35.0	2500	111	L-4	L3	NO	NO	81
GM	C1T061	807207	EMIS	4098	.152	.66	1.19	.207	40.1	2500	111	L-4	M5	NO	NO	81
GM	11B9-1T060F	807958	FE	5440	.173	.59	1.07	.171	36.0	2500	111	L-4	L3	NO	NO	81
GM	11B9-1T062F	808056	FE	5531	.249	.72	1.15	.203	39.5	2500	111	L-4	M5	NO	NO	81
GM	11B9-1T062F	808310	FE	5599	.266	.73	1.12	.236	41.0	2500	111	L-4	M5	NO	NO	81
GM	11B9-1T062F	808537	FE	5789	.221	.71	1.08	.208	40.6	2500	111	L-4	M5	NO	NO	81
GM	L14556-FEC	810618	FE	7777	.182	.76	1.32	.179	24.8	3750	263	V-6	L3	YES	NO	82
GM	L14556-FEC	811781	FE	8415	.186	.61	1.38	.207	24.2	3750	263	V-6	L3	YES	NO	82
GM	L14557	810343	EMIS	3993	.120	.58	1.21	.209	24.5	3750	263	V-6	L3	YES	NO	82
GM	L24555	811572	EMIS	4103	.118	.63	1.23	.324	24.1	3750	263	V-6	L3	YES	NO	82
GM	004646	806557	EMIS	3968	.322	1.00	1.48	.344	21.6	4000	350	V-8	L3	YES	NO	82
GM	006600	804418	EMIS	4039	.312	1.02	1.47	.363	20.9	4250	350	V-8	L3	YES	NO	81
GM	006746	804674	EMIS	3953	.274	1.24	1.02	.702	19.7	4750	350	V-8	L3	YES	NO	81
GM	006760	806311	EMIS	4056	.378	1.18	1.30	.411	19.4	4750	350	V-8	L3	YES	NO	81
GM	006761	805231	EMIS	3956	.340	1.04	1.43	.357	19.7	4750	350	V-8	L3	YES	NO	81
GM	007436	806366	EMIS	4028	.427	1.24	1.13	.456	20.3	4500	350	V-8	A3	YES	NO	81
GM	016531	806487	EMIS	3961	.267	.98	1.59	.337	20.9	4250	350	V-8	L3	YES	NO	81
GM	016531	806637	EMIS	4030	.265	.92	1.41	.332	21.2	4250	350	V-8	L3	YES	NO	81
GM	L14597	809625	EMIS	3871	.216	.77	1.43	.281	22.1	4000	350	V-8	L3	YES	NO	82
GM	L14603-FEC	810447	FE	8001	.222	.82	1.26	.311	22.8	4000	350	V-8	L3	YES	NO	82
GM	L16591	809953	EMIS	3932	.250	.75	1.47	.284	21.4	4250	350	V-8	L3	YES	NO	82
GM	L16751	810883	EMIS	4591	.299	.81	1.40	.292	20.5	4750	350	V-8	L4	YES	NO	82
GM	L17347-FEC	810451	FE	9887	.273	.88	1.42	.308	21.3	4250	350	V-8	L4	YES	NO	82
GM	L17385	809860	EMIS	3969	.221	.81	1.42	.387	20.1	4500	350	V-8	L4	YES	NO	82
GM	L19583-FEC	810443	FE	7847	.309	.88	1.19	.297	22.6	4500	350	V-8	L3	YES	NO	82
GM	L19583-FEC	810445	FE	7890	.335	.88	1.23	.295	22.9	4250	350	V-8	L3	YES	NO	82
GM	L19583-FEC	810518	FE	7934	.317	.99	1.21	.305	22.7	4250	350	V-8	L3	YES	NO	82
GM	L19583-FEC	811014	FE	8687	.159	.81	1.42	.333	22.0	4500	350	V-8	L4	YES	NO	82
GM	L19583-FEC	811016	FE	8643	.183	.83	1.38	.332	22.3	4250	350	V-8	L4	YES	NO	82
GM	L19583-FEC	811103	FE	8731	.182	.82	1.31	.342	22.2	4500	350	V-8	L4	YES	NO	82
GM	L19583-FEC	811287	FE	8957	.156	.79	1.30	.310	22.9	4250	350	V-8	L4	YES	NO	82
ISUZ	PFD60-6703099	807237	EMIS	3861	.181	.56	1.13	.192	40.1	2500	111	L-4	M4	NO	NO	81
ISUZ	PFD60-6703099	807385	FE	3911	.204	.57	1.09	.150	41.1	2500	111	L-4	M4	NO	NO	81
ISUZ	PFD60-6703100	807291	EMIS	3934	.339	.79	1.06	.245	36.2	2625	111	L-4	M5	NO	NO	81
ISUZ	PFD60-6703100	807409	FE	3988	.297	.77	.99	.222	37.9	2625	111	L-4	M5	NO	NO	81
ISUZ	PFD60-6703100	810073	FE	4047	.266	.59	1.18	.198	39.9	2625	111	L-4	M5	NO	NO	82&81
ISUZ	PFD60-6703101	807292	EMIS	3878	.247	.72	1.10	.181	32.7	2750	111	L-4	A3	NO	NO	81
ISUZ	PFD60-6703101	810075	FE	4010	.253	.59	1.07	.182	35.4	2750	111	L-4	A3	NO	NO	82&81
MERC	W 123 D 24-Z 114	805716	EMIS	3966	.217	.95	1.27	.409	29.0	3500	147	L-4	M4	NO	NO	81
MERC	W 123 D 24-Z 115	805535	EMIS	3969	.204	.75	1.52	.373	26.1	3500	147	L-4	A4	NO	NO	81
MERC	W 123 D 24-Z 115	805793	EMIS	4016	.233	.80	1.43	.320	26.6	3500	147	L-4	A4	NO	NO	81

MERC	W 123 D 24-Z 115	806061	EMIS	4071	.215	.78	1.42	.357	27.0	3500	147	L-4	A4	NO	NO	81
MERC	W123D24-Z207	809855	EMIS	3989	.190	1.01	1.16	.461	28.6	3500	147	L-4	M4	YES	NO	82
MERC	W123D24-Z208	810009	EMIS	4094	.196	.80	1.13	.344	26.9	3500	147	L-4	A4	YES	NO	82
MERC	S 123 D 30-Z 118	805612	EMIS	3965	.257	.99	1.29	.436	23.7	3875	183	L-5	A4	YES	NO	81
MERC	S 123 D 30-Z 119	805614	EMIS	3951	.205	.82	1.32	.375	24.8	4000	183	L-5	A4	YES	YES	81
MERC	W 123 D 30-Z 116	805610	EMIS	3954	.197	.91	1.37	.409	23.7	3750	183	L-5	A4	YES	NO	81
MERC	W 123 D 30-Z 116	805795	EMIS	4001	.221	.92	1.29	.382	24.3	3750	183	L-5	A4	YES	NO	81
MERC	W 126 D 30-Z 120	805789	EMIS	4000	.176	1.10	1.31	.548	24.9	4000	183	L-5	A4	YES	YES	81
MERC	W 126 D 30-Z 120	805801	EMIS	4040	.206	1.09	1.20	.501	25.9	4000	183	L-5	A4	YES	YES	81
MERC	W 126 D 30-Z 120	809842	EMIS	4226	.218	.93	1.13	.484	26.6	4000	183	L-5	A4	YES	YES	81
NISS	BDW273	810037	EMIS	4050	.184	.90	1.00	.276	28.4	3375	170	L-6	L3	YES	NO	81
NISS	BD011	807865	EMIS	4319	.197	1.02	1.14	.239	26.8	3375	170	L-6	L3	YES	NO	81
NISS	BDW271	810035	EMIS	4043	.193	1.20	1.14	.226	29.5	3375	170	L-6	M5	YES	NO	82
PEUG	81-630	806396	EMIS	4292	.298	1.42	.80	.399	25.4	3625	141	L-4	M4	YES	NO	81
PEUG	81-630	806522	EMIS	4336	.324	1.48	.82	.384	25.6	3625	141	L-4	M4	YES	NO	81
PEUG	81-690	806349	EMIS	4297	.195	1.37	.97	.492	27.7	3500	141	L-4	M4	YES	NO	81
PEUG	82-276	809766	EMIS	4206	.312	1.26	.78	.310	27.2	3750	141	L-4	M4	YES	NO	82
PEUG	82-639	807926	EMIS	4203	.200	1.24	1.34	.326	26.8	3750	141	L-4	M5	YES	YES	82
PEUG	82-640	807858	EMIS	4060	.203	.97	1.11	.252	23.4	3750	141	L-4	A3	YES	YES	82
PEUG	82-640	808240	EMIS	4109	.287	1.09	1.13	.283	23.4	3750	141	L-4	A3	YES	YES	82
PEUG	82-650	809454	EMIS	4092	.122	.78	1.08	.238	25.3	3750	141	L-4	A3	YES	YES	82
PEUG	82-651	809486	EMIS	4017	.128	1.45	1.12	.239	27.3	3750	141	L-4	M5	YES	YES	82
PEUG	82-652	809450	EMIS	4018	.104	.74	.97	.272	28.1	3500	141	L-4	A3	YES	YES	82
PEUG	82-653	809452	EMIS	4128	.162	1.01	1.06	.223	28.7	3500	141	L-4	M5	YES	YES	82
VOLK	071-608	807625	FE	4373	.366	.95	.88	.208	42.8	2375	97	L-4	M4	NO	NO	81
VOLK	071-608	807681	FE	4415	.345	.80	.83	.184	45.6	2375	97	L-4	M4	NO	NO	81
VOLK	071-608	807726	FE	4466	.232	.75	.87	.176	45.0	2375	97	L-4	M4	NO	NO	81
VOLK	199-728	806262	EMIS	3994	.396	1.10	1.04	.307	36.0	2625	97	L-4	M4	NO	NO	81
VOLK	306-606	805591	EMIS	3949	.233	.76	1.03	.215	41.4	2250	97	L-4	M4	NO	NO	81
VOLK	306-606	805766	EMIS	3992	.272	.90	1.00	.209	42.4	2250	97	L-4	M4	NO	NO	81
VOLK	306-606	806057	EMIS	4102	.329	.96	.89	.182	42.8	2250	97	L-4	M4	NO	NO	81
VOLK	306-607	804693	EMIS	3922	.190	.67	1.04	.206	40.0	2375	97	L-4	M4	NO	NO	81
VOLK	306-608	804696	EMIS	3918	.245	1.10	1.03	.263	38.2	2375	97	L-4	M5	NO	NO	81
VOLK	306-623	806490	EMIS	3967	.316	.74	1.07	.370	38.1	2375	97	L-4	M5	NO	NO	81
VOLK	306-623	806638	EMIS	4053	.268	.80	.96	.217	38.0	2375	97	L-4	M5	NO	NO	81
VOLK	463-835	805167	EMIS	3942	.499	1.00	.92	.277	45.2	2250	97	L-4	M4	NO	NO	81
VOLK	071-609	810189	FE	4015	.228	.80	.86	.191	43.1	2375	97	L-4	M4	NO	NO	82
VOLK	071-609	810240	EMIS	3969	.223	.73	.84	.162	44.1	2375	97	L-4	M4	NO	NO	82
VOLK	071-609	810355	FE	4058	.196	.79	.81	.174	44.9	2375	97	L-4	M4	NO	NO	82
VOLK	071-609	810462	FE	4112	.204	.83	.80	.185	44.6	2375	97	L-4	M4	NO	NO	82
VOLK	071-612	809574	EMIS	3982	.238	.89	.81	.169	43.3	2375	97	L-4	M4	NO	NO	82
VOLK	071-612	809741	FE	4040	.163	.65	.78	.162	46.1	2375	97	L-4	M4	NO	NO	82
VOLK	550-406	809576	FE	3903	.285	.90	.82	.197	40.0	2500	97	L-4	M4	NO	NO	82
VOLK	181-508	810738	EMIS	3991	.179	.85	1.14	.239	35.8	2875	97	L-4	M5	NO	YES	82
VOLK	181-508	810769	FE	4032	.172	.84	1.15	.207	36.1	2750	97	L-4	M5	NO	YES	82
VOLK	181-508	810813	FE	4110	.150	.65	.97	.149	40.5	2750	97	L-4	M5	NO	YES	82
VOLK	181-511	810771	EMIS	3948	.175	.57	1.22	.176	32.0	2875	97	L-4	A3	NO	YES	82
VOLK	550-408	810736	EMIS	3906	.200	.89	1.01	.208	39.7	2500	97	L-4	M5	NO	YES	82
VOLK	550-410	810740	EMIS	3904	.232	.83	1.05	.181	33.9	2625	97	L-4	A3	NO	YES	82
VOLV	81:25	807456	EMIS	4032	.698	1.95	1.29	.319	28.1	3500	145	L-6	M4	NO	NO	81
VOLV	81:25	807510	EMIS	4088	.758	2.04	1.26	.379	27.9	3500	145	L-6	M4	NO	NO	81
VOLV	81:26	807454	EMIS	3950	.597	1.53	1.23	.281	25.9	3375	145	L-6	A3	NO	NO	81
VOLV	81:26	807512	EMIS	4013	.723	1.66	1.17	.315	26.0	3375	145	L-6	A3	NO	NO	81
VOLV	81:27	809309	EMIS	3622	.275	1.22	1.34	.292	29.0	3500	145	L-6	M4	NO	NO	81
VOLV	81:28	809294	EMIS	3881	.184	.94	1.22	.307	26.2	3375	145	L-6	A3	NO	NO	81
VOLV	81:4	809262	DURB	44135	.155	.86	1.34	.421	26.7	3375	145	L-6	A3	NO	NO	81

APPENDIX B-2

DATA ON ALL DIESEL TRUCK FTP TESTS CONDUCTED BY EPA'S CERTIFICATION DIVISION THROUGH DECEMBER 31, 1981

MFR	VEHICLE I.D. NUMBER	TEST NUMBER	TEST TYPE	ODOM	EMISSIONS (G/MI) HC	CO	NOx	TP	MPG	ETW	CID	ENG. CONF	TRAN	EGR ?	TRBO ?	MODEL YEAR
GM	00C237	804704	EMIS	3994	.740	1.60	2.15	.777	18.8	4750	350	V-8	L3	NO	NO	81
GM	00C240	804815	EMIS	3911	.250	1.20	1.14	.792	18.8	5000	350	V-8	L3	YES	NO	81
GM	00C241	804813	EMIS	4036	.310	1.20	1.31	.461	18.7	4750	350	V-8	L3	YES	NO	81
GM	19J9-9C275F	806951	FE	4121	.700	1.70	1.70	.764	18.5	5000	350	V-8	L3	NO	NO	81
GM	C1C244	810223	EMIS	3996	.190	.80	1.91	.289	20.6	5000	379	V-8	L4	YES	NO	82
GM	C1C661	810230	EMIS	3924	.290	1.10	1.64	.222	19.0	5250	379	V-8	L4	YES	NO	82
GM	C1K136	810220	EMIS	3948	.430	1.40	1.42	.301	18.4	6000	379	V-8	L4	YES	NO	82
GM	C1K535	810232	EMIS	4008	.270	1.10	1.52	.384	21.2	5500	379	V-8	M4	YES	NO	82
IHC	410A	805330	EMIS	8145	.190	.80	1.51	.339	19.5	4500	198	L-6	A3	YES	YES	81
IHC	473	805359	EMIS	12265	.120	.70	1.60	.375	20.5	4500	198	L-6	A3	YES	YES	81
ISUZ	B8200095	806880	EMIS	3865	.220	1.20	1.75	.246	31.4	3125	137	L-4	M5	NO	NO	81
ISUZ	B8200095	806941	FE	3929	.180	1.10	1.75	.173	32.1	3000	137	L-4	M5	NO	NO	81
ISUZ	B8200096	806882	EMIS	3805	.240	1.10	1.79	.289	28.2	3250	137	L-4	M4	NO	NO	81
ISUZ	B0709759	811429	FE	3980	.350	1.40	1.31	.346	32.0	3000	137	L-4	M5	YES	NO	82
ISUZ	B0709759	811521	FE	4032	.350	1.30	1.28	.234	33.3	3000	137	L-4	M5	YES	NO	82
ISUZ	B0709759	811551	FE	4059	.300	1.30	1.26	.258	33.1	3000	137	L-4	M5	YES	NO	82
NISS	SW375	806566	EMIS	4018	.300	1.00	1.46	.301	32.0	2875	132	L-4	M5	NO	NO	81
NISS	SW376	806667	EMIS	4106	.290	.90	1.39	.254	34.0	3000	132	L-4	M5	NO	NO	81
NISS	SW476	810563	FE	4046	.390	.90	1.25	.237	32.9	2875	132	L-4	M5	NO	NO	82
NISS	SW477	809768	EMIS	3966	.340	.90	1.30	.236	32.7	3125	132	L-4	M5	NO	NO	82
NISS	SW479	810332	FE	3927	.330	1.10	1.20	.255	33.0	2875	132	L-4	M5	YES	NO	81
NISS	SW480	809578	EMIS	3926	.340	1.50	.93	.243	32.1	3125	132	L-4	M5	YES	NO	81
NISS	SW480	809918	EMIS	3965	.350	1.50	.93	.258	32.6	3125	132	L-4	M5	YES	NO	81
TKM	2ES2T-1	810643	EMIS	4205	.120	.60	1.20	.191	33.1	3250	135	L-4	M5	NO	NO	82
TOTA	81-FTE-6	806959	EMIS	3936	.410	.90	1.17	.200	31.2	3000	134	L-4	M5	NO	NO	81
TOTA	81-FTE-7	806888	EMIS	3993	.260	.80	1.24	.187	32.1	3125	134	L-4	M5	NO	NO	81
VOLK	306-610	804861	EMIS	3940	.360	1.50	1.06	.270	38.3	2375	97	L-4	M5	NO	NO	81
VOLK	071-622	810441	FE	3931	.150	.70	.91	.173	41.3	2375	97	L-4	M4	NO	NO	82
VOLK	162-562	810250	EMIS	3935	.200	1.90	1.20	.361	28.5	4000	97	L-4	M4	NO	NO	82
VOLK	162-562	810257	FE	3935	.200	1.70	1.19	.316	29.5	3625	97	L-4	M4	NO	NO	82

Appendix C

Results of Ames Testing

Appendix C-1

Results of Ames Testing

Sample Number	Test Vehicle	Trap	Test Cycle	Test Date	Analysis Date	Acti-vation	Model Predicted Mean Specific Activity for Strain: (revertants per plate / μg extract) TA100	TA1537	TA1538	TA98
790680	Peugeot	Baseline	HWFE	11-06-79	06-19-80	+	5.59		1.65	2.55
					06-19-80	-	16.25		5.51	8.24
					06-27-80	+	2.53		2.10	2.40
					06-27-80	-	14.68		3.72	11.97
790691	Peugeot	Baseline	LA-4	11-06-79	06-19-80	+	2.14		1.08	1.64
					06-19-80	-	11.32		2.20	2.47
					06-27-80	+	2.35		1.96	1.72
					06-27-80	-	13.04		1.96	3.14
790840	Peugeot	JM-4 #1	HWFE	12-08-79	06-17-80	+	19.24		32.39	41.30
					06-17-80	-	206.20		132.85	27.02
					06-24-80	+	22.27		28.52	52.34
					06-24-80	-	34.70		92.30	28.91
790852	Peugeot	JM-4 #1	LA-4	12-08-79	06-17-80	+	56.62		27.79	31.86
					06-17-80	-	74.00		19.20	44.04
					06-24-80	+	67.85		28.57	35.60
					06-24-80	-	73.83		15.56	30.89
800290	Peugeot	JM-4 #2	HWFE	04-08-80	08-05-80	+	21.58		27.87	21.52
					08-05-80	-	23.03		54.79	31.97
800310	Peugeot	JM-4 #2	LA-4	04-17-80	08-05-80	+	8.29		3.92	15.65
					08-05-80	-	11.12		12.64	11.18

Results of Ames Testing (Continued)

Sample Number	Test Vehicle	Trap	Test Cycle	Test Date	Analysis Date	Acti-vation	Model Predicted Mean Specific Activity for Strain: (revertants per plate / µg extract) TA100	TA1537	TA1538	TA98
800260	Mercedes	EX-47 12" non-cat.	LA-4	03-18-80	08-04-80	+	2.41		0.88	0.87
					08-04-80	-	7.21		0.90	2.23
800280	Mercedes	EX-47 12" non-cat.	LA-4	03-20-80	08-05-80	+	15.07		11.15	12.94
					08-05-80	-	17.12		5.10	15.81
810011	Mercedes	ICI 4th generation	HWFE	03-18-81	06-16-81	+	30.0	10.2		7.1
					06-16-81	-	47.2	26.4		14.0
810040	Mercedes	ICI 4th generation	LA-4	02-20-81	06-16-81	+	15.7	4.5		4.8
					06-16-81	-	88.8	5.2		13.1

Appendix C-2

Results of Ames Testing of Prototype Vehicles

Sample Number	Test Vehicle	Test Cycle	Test Date	Analysis Date	Activation	Model Predicted Mean Specific Activity for Strain: (revertants per plate / μg extract) TA100	TA1535	TA1537	TA1538	TA98
790721	Mercedes 300 SD *1980 Cert. Vehicle*	HWFE	11/14/79	06/19/80	+	11.13			7.14	15.08
				06/19/80	-	33.72			15.12	15.12
				06/27/80	+	11.18			11.51	15.32
				06/27/80	-	22.54			13.47	13.47
790771	Mercedes 300 TD *1980 Cert. Vehicle*	HWFE	11/20/79	06/19/80	+	5.49			9.37	8.65
				06/19/80	-	21.73			17.46	17.46
				06/27/80	+	8.76			54.77	8.90
				06/27/80	-	147.27			11.05	11.05
790800	Mercedes 300 TD *1980 Cert. Vehicle*	HWFE	11/21/79	06/19/80	+	4.06			4.28	7.34
				06/19/80	-	15.97			7.96	7.96
				06/27/80	+	5.55			7.74	7.49
				06/27/80	-	15.48			5.91	5.91
790891	Peugeot 504 Turbo Diesel *1981 Calif. Prototype 141 CID*	HWFE	12/18/79	06/18/80	+	5.15	0.86	0.68	2.31	3.40
				06/18/80	-	14.35	0.86	1.89	6.10	8.95
				06/25/80	+	4.43	1.40	0.95	2.65	3.10
				06/25/80	-	20.16	0.03	1.52	6.45	9.15
790941	Peugeot 504 Turbo Diesel *1981 Calif. Prototype 141 CID*	HWFE	12/20/79	06/18/80	+	2.50	0.05			
				06/18/80	-	14.58	Negative			
				06/25/80	+	2.25	0.19			
				06/25/80	-	15.79				

Appendix C-3

Results of Ames Testing of In-Use Vehicles

Privately Owned, 1978 Model Year, High Mileage (over 40,000 miles), Oldsmobile, 350 CID, Diesel Cars

Sample Number	Test Vehicle	Test Cycle	Test Date	Analysis Date	Acti-vation	Model Predicted Mean Specific Activity for Strain: (revertants per plate / µg extract) TA100	TA1535	TA1537	TA1538	TA98
780911	Delta 88	HWFE	12/20/79	07/30/80	+	5.33			3.46	3.84
				07/30/80	-	19.90			8.06	14.23
				08/15/80	+	4.79			3.86	5.08
				08/15/80	-	25.94			7.42	13.96
				08/18/80	+	6.88			3.80	8.37
				08/18/80	-	20.63			6.42	13.98
800011	Delta 88	HWFE	01/02/80	07/30/80	+	3.91			2.78	3.84
				07/30/80	-	11.68			3.10	10.59
				08/15/80	+	6.95			2.83	3.68
				08/15/80	-	12.49			4.27	10.01
800031	Delta 88	HWFE	01/10/80	07/30/80	+	6.33			3.16	7.34
				07/30/80	-	21.20			3.92	12.49
				08/18/80	+	7.16			3.21	9.66
				08/18/80	-	22.78			3.70	13.03
800050	Oldsmobile 98	HWFE	01/16/80	07/29/80	+	7.53			12.70	11.31
				07/29/80	-	8.22			16.56	10.75
				08/11/80	+	6.80			6.19	10.45
				08/11/80	-	15.37			16.51	19.32
800060	Oldsmobile 98	HWFE	01/16/80	07/29/80	+	4.09			7.23	10.08
				07/29/80	-	8.54			15.00	11.03
				08/11/80	+	5.14			3.23	8.65
				08/11/80	-	21.76			8.25	13.66
800070	Olds Custom Cruiser Wgn	HWFE	01/23/80	07/29/80	+	12.84			12.42	10.72
				07/29/80	-	7.78			11.20	12.52
				08/11/80	+	8.31			3.09	13.56
				08/11/80	-	32.08			9.78	13.25

Results of Ames Testing from In-Use Program (Continued)

Sample Number	Test Vehicle	Test Cycle	Test Date	Analysis Date	Activation	Model Predicted Mean Specific Activity for Strain: (revertants per plate / μg extract) TA100	TA1535	TA1537	TA1538	TA98
800080	Oldsmobile 98	HWFE	01/23/80	07/29/80	+	9.66			6.61	6.58
				07/29/80	-	11.50			5.28	10.56
800140	Delta 88	HWFE	01/30/80	07/31/80	+	3.86			8.09	6.01
				07/31/80	-	7.54			5.37	6.38
800150	Oldsmobile 98	HWFE	01/30/80	07/31/80	+	14.21			12.53	7.97
				07/31/80	-	23.03			8.22	9.03
800160	Oldsmobile 98	HWFE	02/07/80	07/31/80	+	9.15			6.72	10.90
				07/31/80	-	11.03			6.45	7.08
800170	Oldsmobile 98	HWFE	02/07/80	07/31/80	+	8.12			6.44	6.47
				07/31/80	-	15.35			5.17	6.77
800190	Delta 88	HWFE	02/25/80	08/01/80	+	17.38			11.78	9.14
				08/01/80	-	18.42			14.36	12.59
800200	Oldsmobile 98	HWFE	02/14/80	08/01/80	+	17.86			6.86	7.99
				08/01/80	-	16.76			8.08	7.19
800210	Delta 88	HWFE	02/20/80	08/01/80	+	11.70			30.49	10.95
				08/01/80	-	48.95			36.90	26.31

Appendix C-4

Summary of Ranges of Preliminary Ames Data

	Test Cycle	Specific Activity (revertants per plate per microgram of extract) for Strains: TA100 +	TA100 -	TA1538 +	TA1538 -	TA98 +	TA98 -
No Trap (c)	LA-4	2.14 - 2.35	11.32 - 13.04	1.08 - 1.96	1.96 - 2.20	1.64 - 1.72	2.47 - 3.14
	HWFE	2.53 - 5.59	14.68 - 16.25	1.65 - 2.10	3.72 - 5.51	2.40 - 2.55	8.24 - 11.97
Uncatalyzed Trap (c)	LA-4	2.41 - 15.07	7.21 - 17.12	0.88 - 11.15	0.90 - 5.10	0.87 - 12.94	2.23 - 15.81
	HWFE	---	---	---	---	---	---
Catalyzed Trap (d)	LA-4	8.29 - 67.85	11.12 - 88.8	3.92 - 28.57	12.64 - 23.03	4.8 - 35.60	11.18 - 44.04
	HWFE	19.24 - 30.0	21.58 - 206.2(b)	27.87 - 32.39	54.79 - 132.8	7.1 - 52.34	14.0 - 31.97
No Trap (a)	LA-4	---	---	---	---	---	---
	HWFE	2.25 - 17.86	7.54 - 147.3(b)	2.31 - 54.77	3.10 - 36.90	3.10 - 15.32	5.91 - 26.31

(a) From other test programs.
(b) Questionable value.
(c) From a single vehicle.
(d) From only two vehicles.

Appendix D

Emissions Measured During Regeneration Cycles

APPENDIX D

EMISSIONS MEASURED DURING 60 MPH STEADY-STATE REGENERATIONS

VEHICLE I.D. 11511412019885 (1975 MERCEDES BENZ 300D)

TEST NUMBER	BAG #	TEST DATE	ODOM (mi)	EMISSIONS (g/mi) HC	CO	NOx	TP	MPG	TRAP	THROTTLE CONDITION
797445	1	04-13-79	30497	.069	.573	2.390	.421	24.2	DUMMY TRAP	Unthrottled Inlet
797445	2	04-13-79	30497	.073	.428	2.293	.241	24.4	DUMMY TRAP	Throttled Inlet @ 7" Hg of vacuum
797446	1	04-13-79	30521	.046	.400	2.158	.164	24.0	DUMMY TRAP	Throttled Inlet @ 9" Hg of vacuum
797446	2	04-13-79	30521	.059	.403	2.105	.170	23.3	DUMMY TRAP	Throttled Inlet @ 10" Hg of vacuum
799476	1	10-15-79	35227	.060	.430	1.943	.294	25.0	DUMMY TRAP	Throttled Inlet @ 9" Hg for 8 min
799476	2	10-15-79	35227	.070	.481	2.009	.358	29.0	DUMMY TRAP	Unthrottled Inlet for 4 min
799479	1	10-16-79	35307	N/R	.406	1.990	.249	24.7	DUMMY TRAP	Throttled Inlet @ 9" Hg for 8 min
799479	2	10-16-79	35307	N/R	.491	2.088	.363	28.1	DUMMY TRAP	Unthrottled Inlet for 4 min
799480	1	10-19-79	35433	.067	.689	1.783	.155	28.0	ICI Saffil	Throttled Inlet @ 9" Hg for 8 min
799480	2	10-19-79	35433	.060	.690	1.768	.329	31.1	ICI Saffil	Unthrottled Inlet for 4 min
799483	1	10-25-79	35790	.051	1.302	1.897	.160	24.9	ICI Saffil	Throttled Inlet @ 9" Hg for 8 min
799483	2	10-25-79	35790	.042	.827	2.055	.303	27.7	ICI Saffil	Unthrottled Inlet for 4 min
802070	1	04-08-80	39363	N/R	6.077	1.599	.221	22.0	Corning 12" non-catalyzed	Throttled Inlet @ 9" Hg for 8 min
802070	2	04-08-80	39363	N/R	1.223	1.901	N/R	27.7		Unthrottled Inlet for 4 minutes
810787	1	10-09-81	42458	.091	.006	1.889	3.019	23.2	Corning 12" w UOP Coating	Throttled Inlet @ 9" Hg for 8 min
810787	2	10-09-81	42458	.066	.038	1.568	.998	33.0		Unthrottled Inlet for 4 minutes
811170	1	10-21-81	42619	.070	.006	1.894	1.509	22.8	Corning 12" w UOP Coating	Throttled Inlet @ 9" Hg for 8 min
811170	2	10-21-81	42619	.066	.035	2.042	1.930	26.8		Unthrottled Inlet for 4 minutes
811764	1	12-09-81	43264	.021	1.979	1.852	.113	23.0	NGK #2	Throttled Inlet @ 9" Hg for 8 min
811764	2	12-09-81	43264	.014	.592	2.121	.104	26.0	NGK #2	Unthrottled Inlet for 4 minutes
811823	1	12-23-81	43547	.017	4.918	1.681	.081	21.8	NGK #2	Throttled Inlet @ 9" Hg for 8 min
811823	2	12-23-81	43547	.013	.806	2.132	.115	25.9	NGK #2	Unthrottled Inlet for 4 minutes
811824	1	01-06-82	43590	.017	3.158	1.668	N/R	22.0	NGK #2	Throttled Inlet @ 9" Hg for 8 min
811824	2	01-06-82	43590	.015	2.230	2.089	N/R	25.5	NGK #2	Unthrottled Inlet for 4 minutes

EMISSIONS MEASURED DURING 60 MPH STEADY-STATE REGENERATIONS

VEHICLE I.D. K-LS110-SEMFSY (1981 TOYOTA CROWN SUPER-DELUX)

TEST NUMBER	BAG #	TEST DATE	ODOM (km)	EMISSIONS (g/mi) HC	CO	NOx	TP	MPG	TRAP	THROTTLE CONDITION
811576	1	11-18-81	4053	.141	7.090	1.181	.126	24.7	NGK #1	Throttled Inlet @ 9" Hg vac for 8 min
811576	2	11-18-81	4053	.149	1.968	1.144	.125	33.2	NGK #1	Unthrottled Inlet for 4 minutes
811788	1	12-11-81	4763	.139	8.769	1.145	N/R	23.9	NGK #1	Throttled Inlet @ 9" Hg vac for 8 min
811788	2	12-11-81	4763	.195	1.410	1.355	N/R	30.5	NGK #1	Unthrottled Inlet for 4 minutes
811986	1	01-08-82	5595	.139	8.015	1.216	.226	24.5	NGK #1	Throttled Inlet @ 9" Hg vac for 8 min
811986	2	01-08-82	5595	.175	2.849	1.324	.218	29.3	NGK #1	Unthrottled Inlet for 4 minutes

Appendix E

Sensitivity Analysis

The sensitivity of FTP fuel economy (FE) relative to exhaust gas backpressure (EGBP) is defined to be the quotient of the percent change in FE divided by the corresponding percent change in EGBP. (The percent change in FE is calculated by multiplying 100 percent times the quotient of the change in FE divided by the average FE over that interval, similarly for EGBP.)

For each of the 17 intervals on the following eight figures, we assumed that, between regeneration points, the relationship between FE and mileage accumulation (solid line) was linear, and that the relationship between EGBP and mileage accumulation (dotted line) was also linear. We will ignore, for the purpose of this analysis, the fact that for the non-catalyzed Corning trap (intervals VI, VII, and VIII) the EGBP data were measured at 50 miles per hour (mph) instead of the 60 mph for the remaining 14 intervals.

Based on the above assumptions of linearity, we calculated the following sensitivities in each of the 17 intervals between regenerations:

Interval	Sensitivity
I	+1.300
II	-0.072
III	+0.278
IV	-0.073
V	-0.105
VI	-0.070
VII	-0.115
VIII	-0.048
IX	-0.027
X	-0.085
XI	-0.017
XII	-0.042
XIII	-0.032
XIV	-0.079
XV	-0.050
XVI	+0.015
XVII	-0.102

The mean of the above 17 sensitivities is +0.040 with a standard deviation of 0.337. If we consider the sensitivities of intervals I and III to be outliers and omit them, we obtain a mean of -0.060 and a standard deviation of 0.036 for the remaining 15 intervals.

For the sensitivity value of -0.060, the new fuel economy value is $FE_2 = FE_1 (1 - 0.030a)/(1 + 0.03a)$, where a is the change in backpressure divided by the average back pressure. As an example, for an initial fuel economy value of 26 mpg, and a backpressure rise from 20 to 100 inches of water at 60 mph,

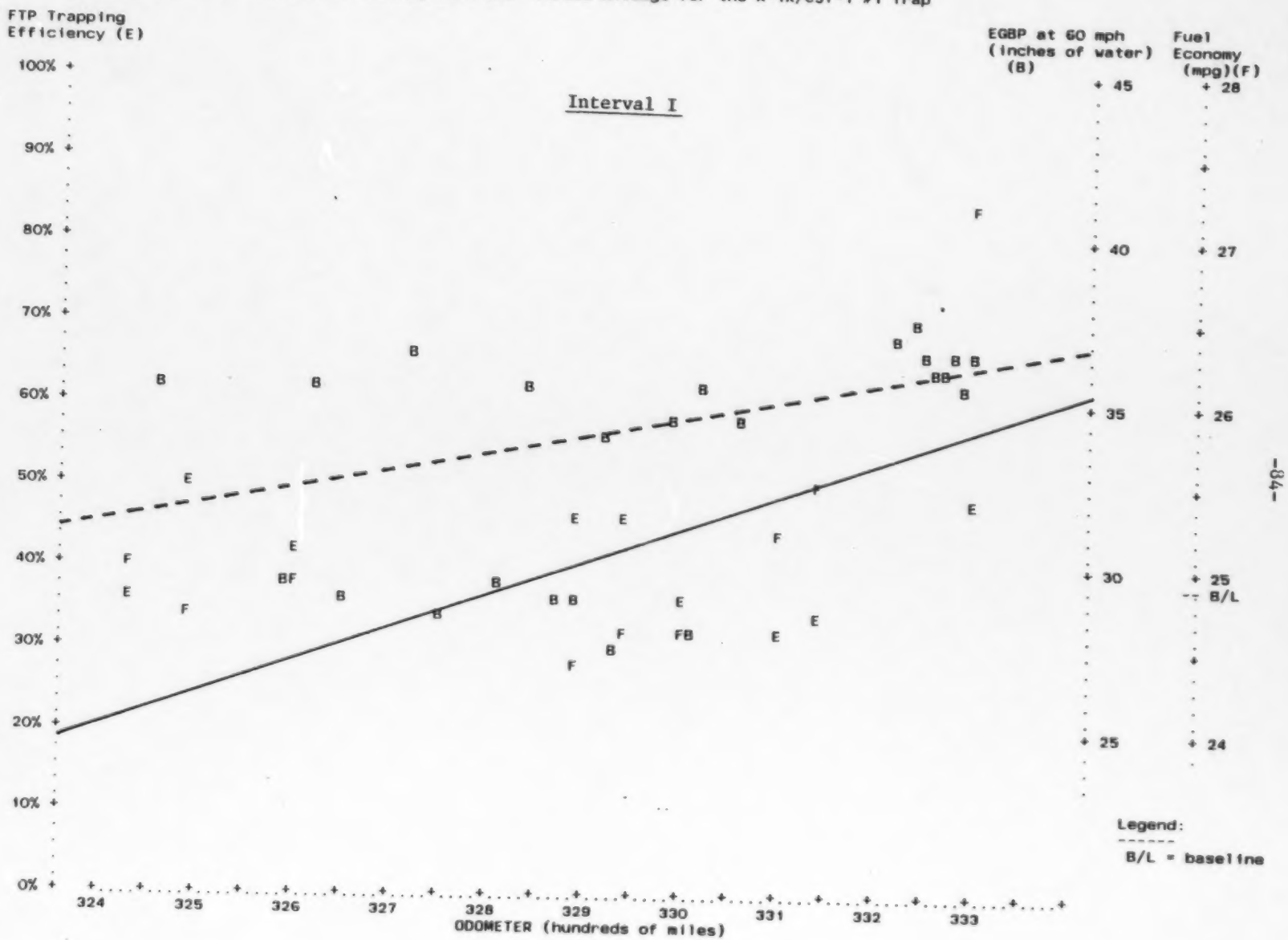
$$FE_2 = 26 (1 - 0.030 (80)/60)/(1 + 0.030 (80)/60)$$
$$FE_2 = 24 \text{ mpg (a 7.7\% loss at 100 inches of water backpressure).}$$

As a further example, we could ask what the effect on FE would be if we were to install a particulate trap on a Diesel vehicle, initially increasing its EGBP from 20 inches to 40 inches and then gradually loading the trap until the EGBP increases to 120 inches. Assuming an initial FE of 26 mpg and a sensitivity of -0.060, installing the trap would result in initially reducing the FE to 25.0 mpg, and then allowing the EGBP to increase an additional 80 inches would further reduce the FE to 23.5 mpg. Thus, the average FE obtained while using the trap would be 24.3 mpg, for an overall loss of about 7% compared to the 26 mpg of the vehicle without the trap.

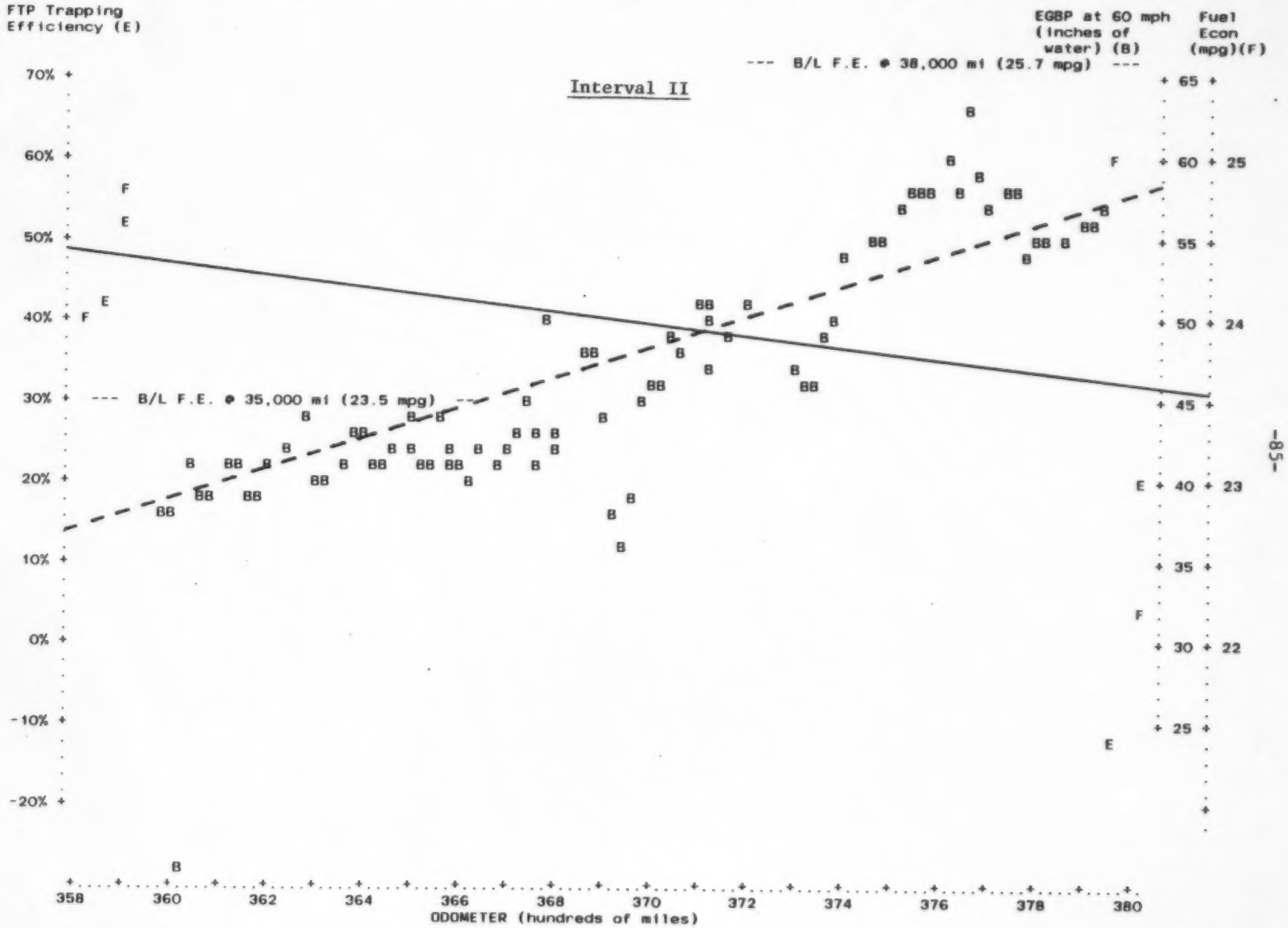
Other examples of initial and mileage accumulation backpressure increase could be considered, in order to simulate different traps and/or regeneration intervals. The sensitivity value of -0.060 is considered to be conservative for two reasons. First, data that showed fuel economy increases concurrent with increased backpressure were deleted in two cases in the calculation of the mean sensitivity. Second, even though backpressure increases that occur over mileage reduce fuel economy, backpressure increases due to trap installation do not always reduce fuel

economy. By ignoring these counterintuitive examples which exist in the data (see Appendix A), the sensitivity of -0.060 is considered to be one that would tend to overpredict fuel economy losses due to trap installation and mileage accumulation with the trap installed.

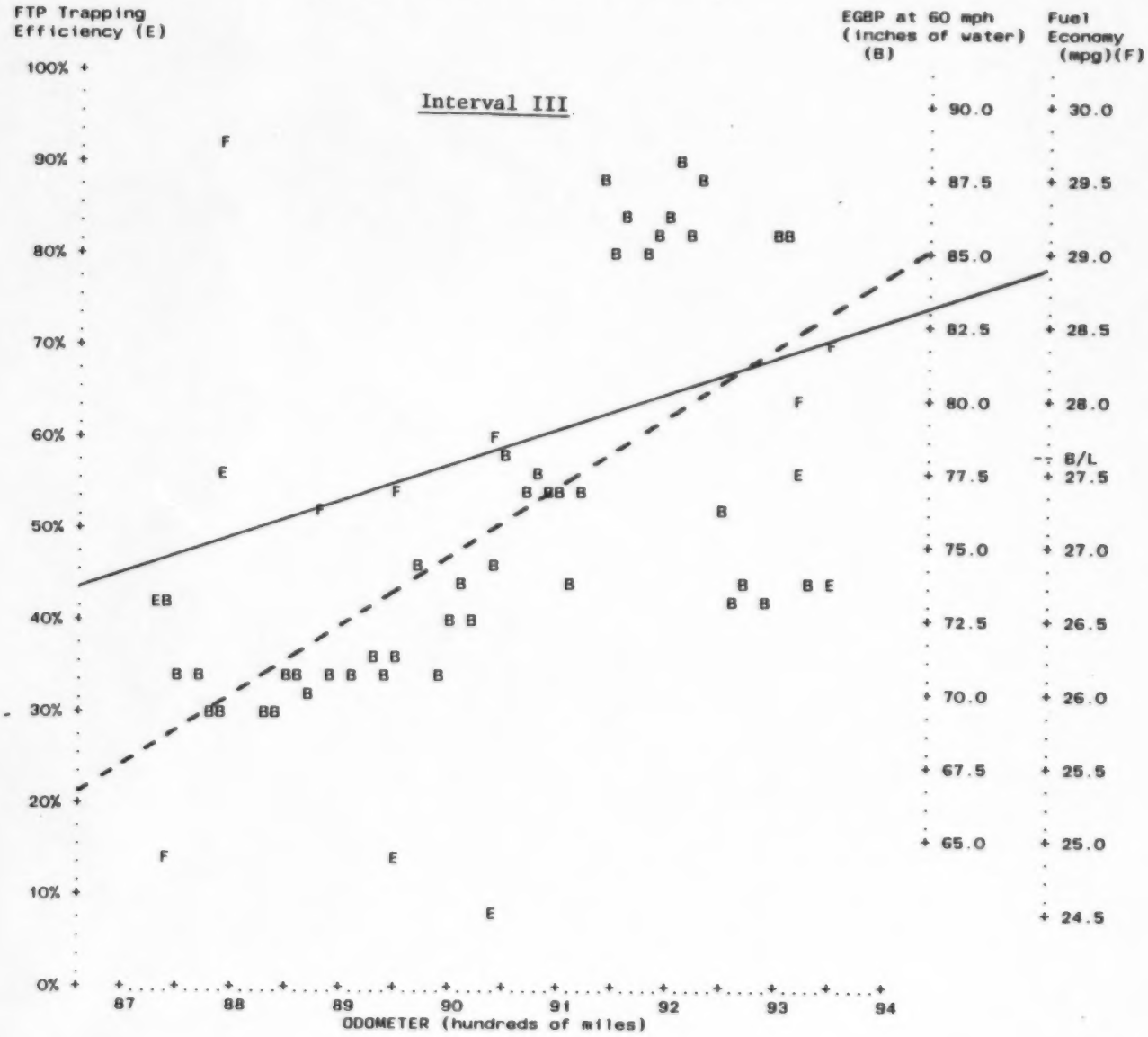
Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the A-1R/CST-1 #1 Trap



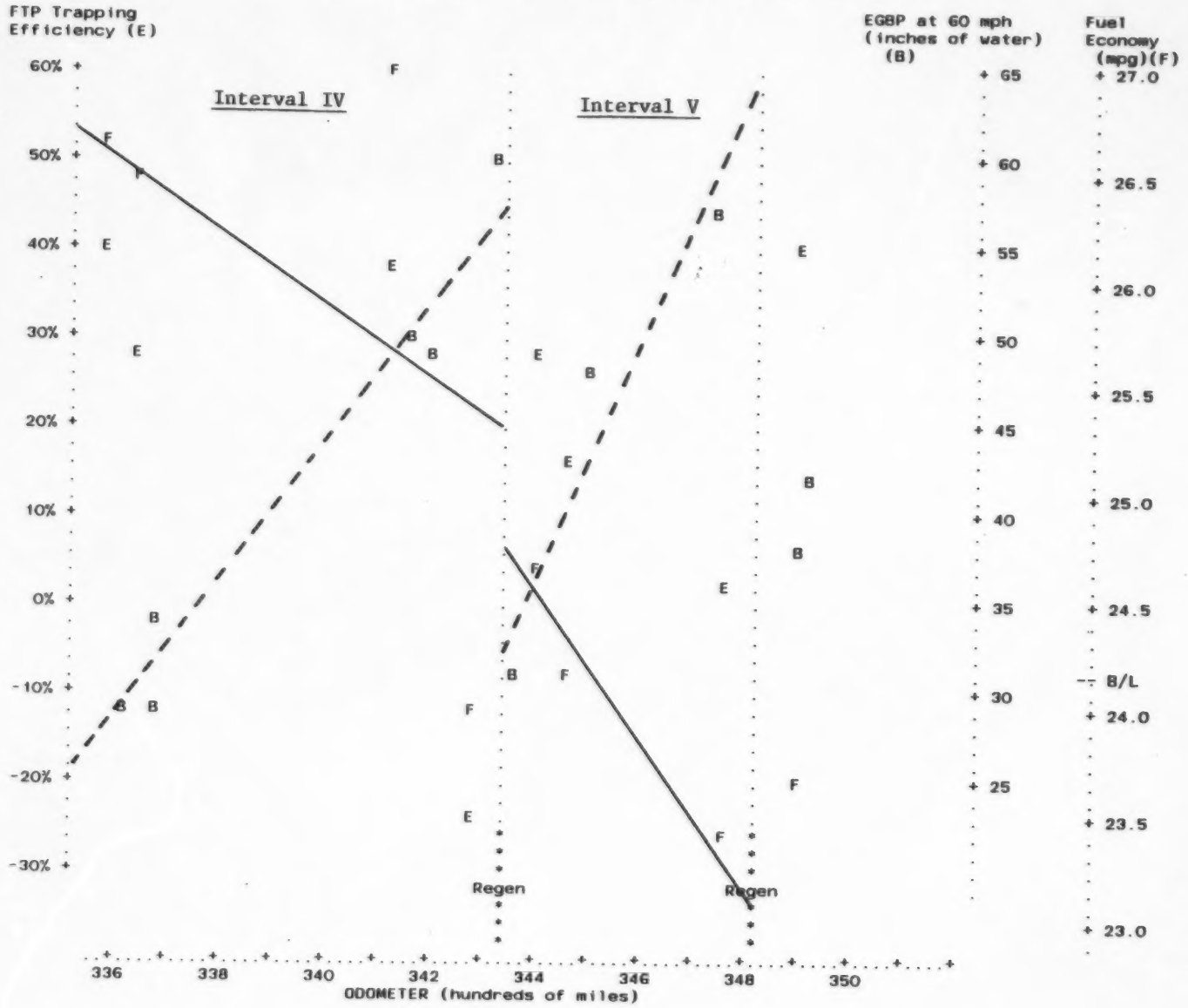
Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the A-1R/CST-1 #2 Trap



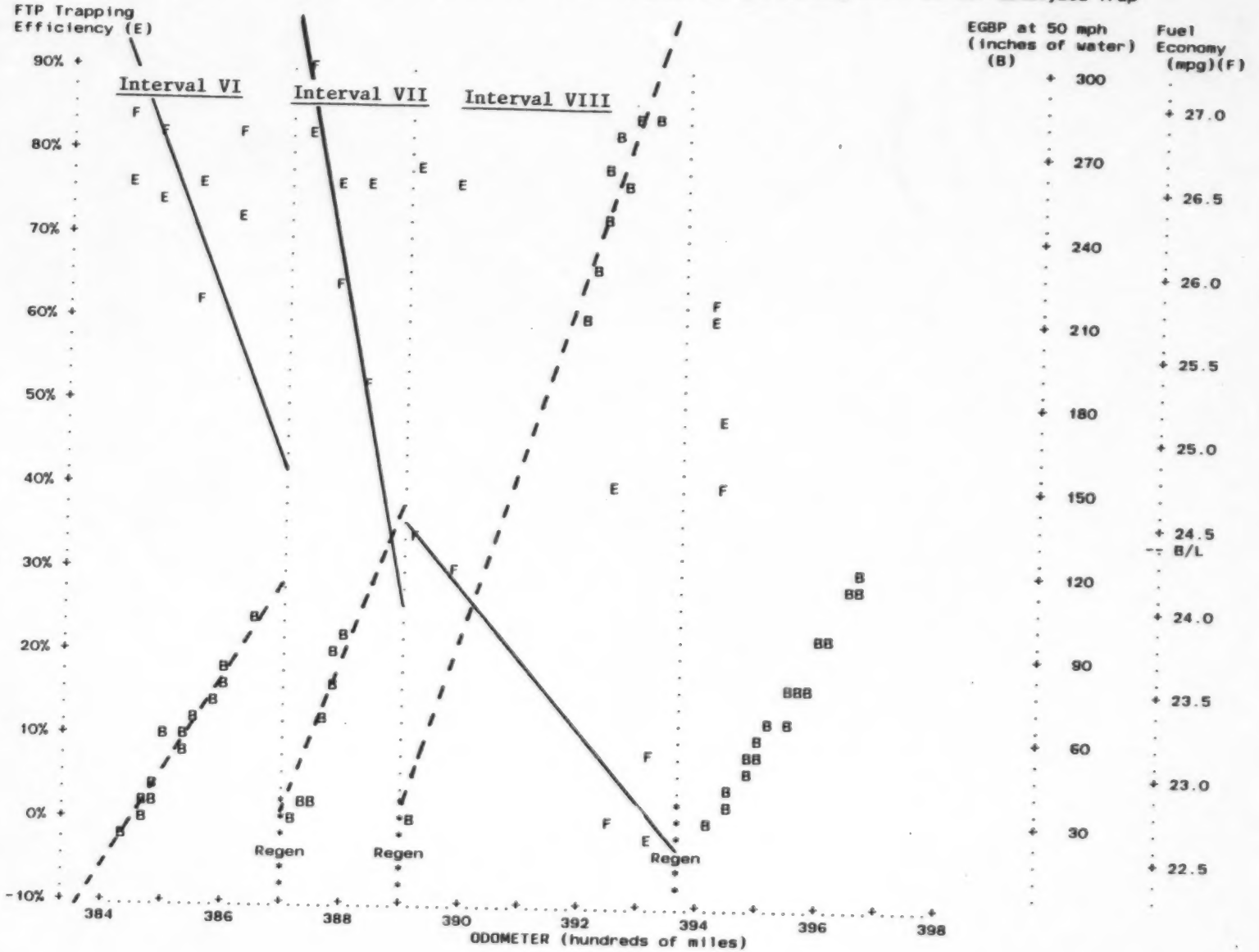
Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the JM-4 #2 Trap

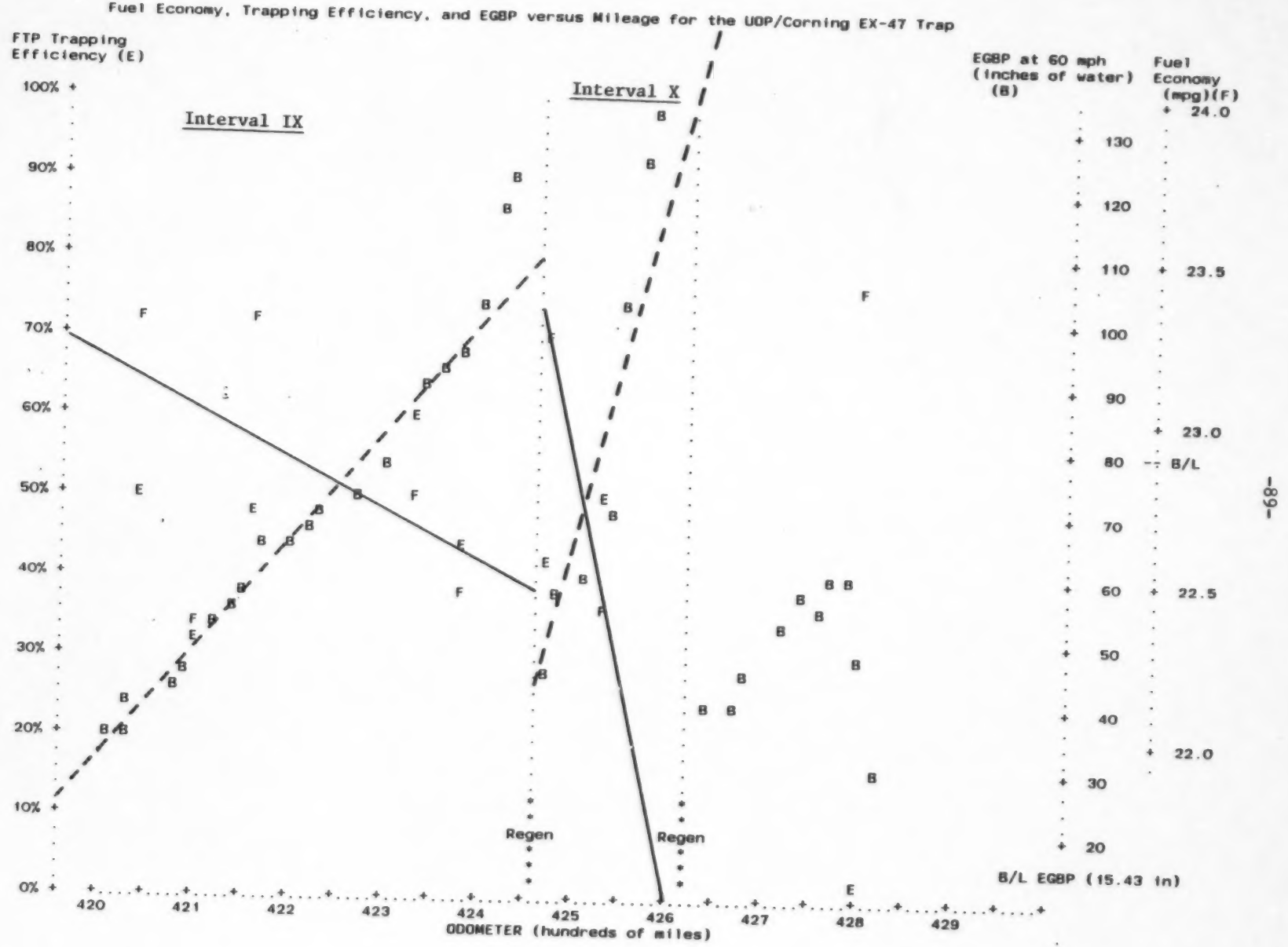


Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the ICI Saffil Trap

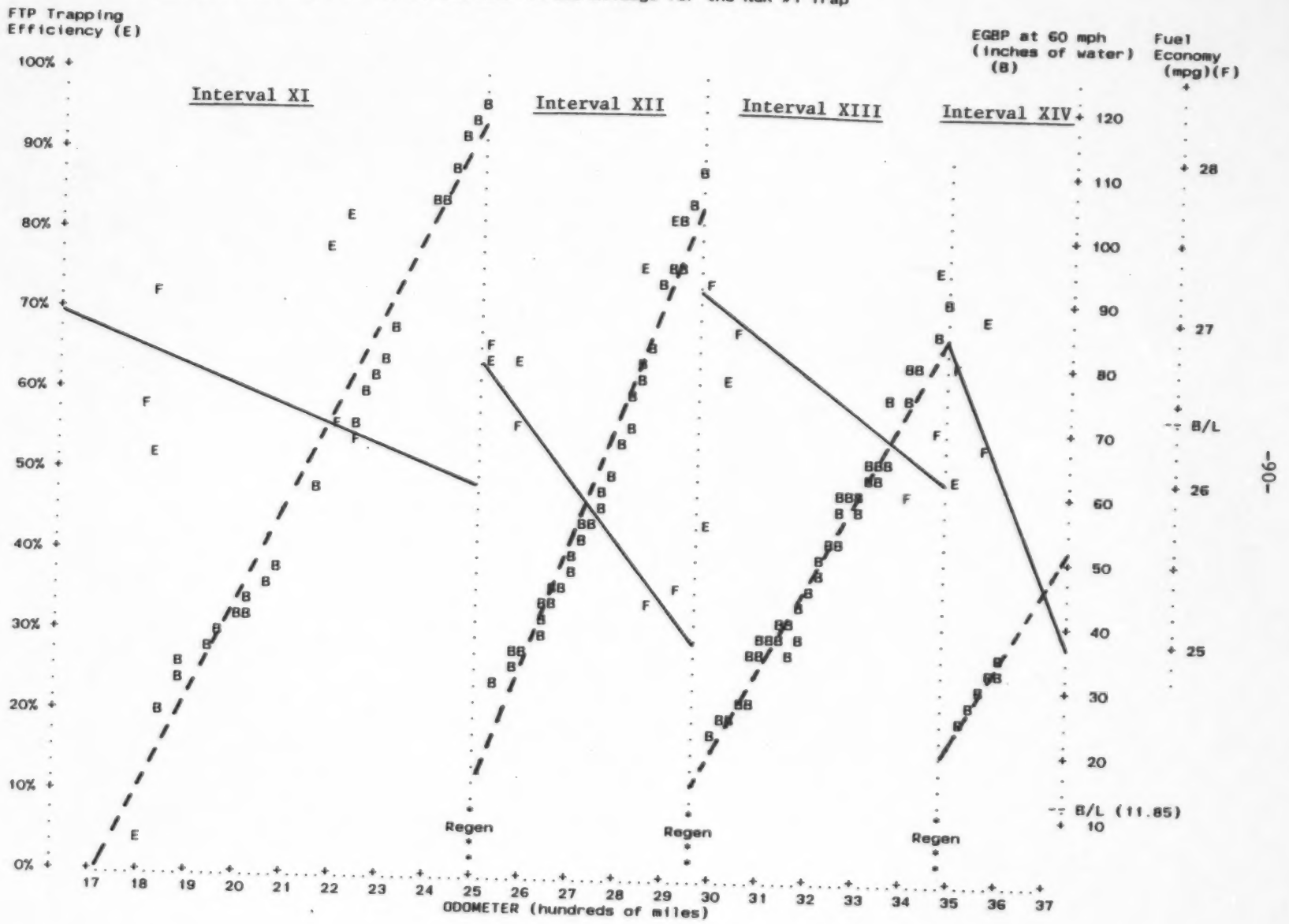


Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the Corning EX-47 12" non-catalyzed Trap




Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the UOP/Corning EX-47 Trap
FTP Trapping Efficiency (E)
EGBP at 60 mph (inches of water) (B)
Fuel Economy (mpg)(F)
Interval IX
Interval X
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
130
120
110
100
90
80
70
60
50
40
30
20
24.0
23.5
23.0
22.5
22.0
B/L
Regen
Regen
420
421
422
423
424
425
426
427
428
429
ODOMETER (hundreds of miles)
B/L EGBP (15.43 in)

Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the NGK #1 Trap



Fuel Economy, Trapping Efficiency, and EGBP versus Mileage for the NGK #2 Trap